Africa RISING East and Southern Africa Project

2018/2019 Workplan

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www.africa-rising.net

The Africa Research in Sustainable Intensification for the Next Generation (Africa RISING) program comprises three research-in-development projects supported by the United States Agency for International Development as part of the U.S. government's Feed the Future initiative.

Through action research and development partnerships, Africa RISING will create opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base.

The three regional projects are led by the International Institute of Tropical Agriculture (in West Africa and East and Southern Africa) and the International Livestock Research Institute (in the Ethiopian Highlands). The International Food Policy Research Institute leads the program's monitoring, evaluation and impact assessment. http://africa-rising.net/

ILRI INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

IFPRI

IITA Transforming African Agriculture

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Contents

Outcomes, outputs and activities of the Africa RISING ESA Project Phase 2

Outcome 1: Productivity, diversity, and income of crop-livestock systems in selected agro-ecologies enhanced under climate variability	
Output 1.1: Demand-driven, climate-smart, integrated crop-livestock research products (contextualized technologies) for improved productivity, diversified diets, and higher income piloted for specific typologies in target agro-ecologies and scaled in Outcomes 4 and 5	Activity 1.1.1: Assess and iteratively improve crop-livestock systems Activity 1.1.2: Evaluate and implement pathways that are effective at improving access to seeds and clonal materials of modern varieties of legumes, cereals, vegetables, and forages
Output 1.2: Demand-driven, labor-saving and gender-sensitive research products to reduce drudgery while increasing labor efficiency in the production cycle piloted for relevant typologies in target areas [and scaled in Outcomes 4 and 5]	Activity 1.2.1: Support local partners through training on appropriate drudgery-reducing technology delivery Activity 1.2.2: Co-adapt existing mechanization options with target communities
Output 1.3: Tools (including ICT-based) and approaches for disseminating recommendations in relation to above research products, integrated in capacity development [and used in Outcomes 4 and 5]	Activity 1.3.1: Conduct extrapolation domain analysis based on GIS, agro-ecology, and crop model-generated information to establish the potential of technologies for geographical reach
Outcome 2: Natural resource integrity and resilience to climate change enhanced for the target communities and agro-ecologies	
Output 2.1: Demand-driven research products for enhancing soil, land and water resources management to reduce household/community vulnerability and land degradation piloted in priority agro-ecologies [and scaled in Outcome 5]	Activity 2.1.1: Characterize current practices in ESA through identifying formal and informal arrangements for access to and use of water and land resources Activity 2.1.2: Identify opportunities for using supplementary irrigation in different farming systems of the ESA target country agro-ecologies
Output 2.2: Innovative options for land and water management in selected farming systems demonstrated at strategically located learning sites [and scaled in Outcome 5]	Activity 2.2.1: Set up demonstration and learning sites in target ESA communities
Outcome 3: Food and feed safety, nutritional quality, and income security of target smallholder families improved equitably (within households)	
Output 3.1: Demand-driven research products to reduce postharvest losses and improve food quality and safety piloted in target areas [and scaled in Outcome 5]	Activity 3.1.1: Conduct packaging and delivery of postharvest technologies through community and development partnerships with iterative review, refining, and follow-up
Output 3.2: Nutritional quality improved through increased accessibility and use of nutrient-dense crops and livestock products.	Activity 3.2.1: Promote and deploy nutrient-rich crop varieties and livestock feed resources in target communities

Outcome 4:: Functionality of input and output markets and other institutions to deliver demand-driven sustainable intensification research products improved	
Output 4.1: Access to profitable markets for smallholder farming communities and priority value chains facilitated	Activity 4.1.1: Conduct comprehensive value-chain analysis with a specific focus on SI technologies Activity 4.1.2: Conduct a value chain stakeholder analysis (stakeholder mapping) Activity 4.1.3: Develop a value chain enhancement strategy (including collective action approaches, contractual arrangements, and standardization Activity 4.1.4: Identify and evaluate existing mechanisms that inform farmers about dynamic market needs Activity 4.1.5: Conduct an analysis of the existing baseline survey data and supplement them with qualitative surveys from target regions
Outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations operationalized	
Output 5.1: Opportunities for the use and adoption of sustainable intensification technologies identified for relevant farm typologies	Activity 5.1.1: Farmer participatory experimentation with crop and soil management and integrated crop-livestock technologies in on-farm situations Activity 5.1.2: Use farm trial data to apply crop simulation models (APSIM) and assess performance over space and time, including assessment of climate-smart technologies to establish the potential for adaptation and mitigation Activity 5.1.3: Establish adaptive field experiments with mineral and crop/animal-derived organic manure Activity 5.1.4: Demonstrate the use and impact of crop residues, forages, and other organic resources as animal feed and nutrient resources Activity 5.1.5: Use crop-livestock models for trade-off analysis Activity 5.1.6: Disseminate best-fit integrated crop-livestock technologies to reach and have effect on small-scale farmers in a landscape context
Output 5.2: Strategic partnerships with public and private, initiatives for the diffusion, and adoption of research products established	Activity 5.2.1: Leverage/link and integrate (engagement and outreach) with existent initiatives including Government extension systems to support and encourage the delivery pathways Activity 5.2.2: Leverage/link and integrate (engagement and outreach) with existent initiatives including

	Government extension systems to support and encourage the delivery pathways
Output 5.3: Gender-sensitive decision support tools for farmers to assess technology-associated risk and opportunities used by partners	Activity 5.3.1: Identify and communicate gender-sensitive decision support technologies in the context of different farm typologies
Output 5.4: A technology adoption, monitoring, evaluation, and learning framework for use by the project team and scaling partners released [led by IFPRI and used by project partners]	Activity 5.4.1: Monitor and modify the progress of technology adoption process towards scaling Activity 5.4.2: Develop knowledge sharing centers and learning alliances within existent local and regional institutions

Partners and their responsibilities

Name	Acronym	Role/responsibility
Government Ministries & Entities		
District Government Authorities		Facilitating (farmer) contacts, supervising field activities & scaling
National Academic and National Research Institutions		
Tanzania Agricultural Research Institute	TARI	Research and scaling with its Centres Selian, Naliendele, Hombolo and, Dakawa
Zambia Agriculture Research Institute	ZARI	Research and scaling with Masekera Research Institute
Sokoine University of Agriculture	SUA	Research and technology delivery; graduate student training
University of Dodoma	UDOM	Research and technology delivery; graduate student training
Lilongwe University of Agriculture and Natural Resources	LUANAR	Implementing research and scaling; graduate student training
International Research Institutions and Universities		
International Institute of Tropical Agriculture	IITA	Project Management, research and technology delivery; student mentoring
International Center for Tropical Agriculture	CIAT	Research and technology delivery; student mentoring
International Crops Research Institute for the Semi-Arid Tropics	ICRISAT	Research and technology delivery; student mentoring
International Food Policy Research Institute	IFPRI	Monitoring & Evaluation and research
International Livestock Research Institute	ILRI	Research and technology delivery; student mentoring
International Maize and Wheat Improvement Centre	CIMMYT	Research and technology delivery; student mentoring
World Vegetable Centre	WorldVeg	Research and technology delivery; student mentoring
World Agroforestry Centre	ICRAF	Research and technology delivery; student mentoring
Michigan State University	MSU	Research and technology delivery; student mentoring
Wageningen University and Research Centre	WUR	Research and technology delivery; student mentoring
Private organizations and development projects		
Cereals Market System Development	NAFAKA	A consortium of private and public development partners for taking technologies to scale
Islands of Peace	IDP	A consortium of private and public development partners for taking technologies to scale
Catholic Relief Services	CRS	Taking technologies to scale
Community Market for Conservation	COMACO	Taking technologies to scale

Total Land Care	TLC	Taking technologies to scale
Production Finance and Improved Technology Plus	PROFIT+	Taking technologies to scale

Summary

The Africa RISING - East and Southern Africa (ESA) Project is being implemented by multi-disciplinary research teams and development partners from the public and private sectors in collaboration with farmers and community-based organizations in Tanzania, Malawi and Zambia. This document presents the work planned for the 2018-2019 research year for ESA but mapped under the five Outcomes in the Phase II project log frame. Therefore, not all Activities are being implemented; some may have been implemented before and others will be implemented in the coming years of Phase II. Although outcomes appear somewhat thematic, solutions generated under the several sub-activities may be combined into suites of practices to be applied concurrently or consecutively depending on their opportunity for application. Outcomes 1 to 3 consists of sub-activities mainly aiming at completing validation of technologies initiated in Phase I, especially under the guidance of the new Sustainable Intensification Assessment Framework (SIAF), but also explore new research areas emerging from Phase 1 experiences and feedback by research and development partners. Because of the importance of economics as a main driver to technology adoption, Outcome 4 deliberately addresses the enabling environment for this to happen. Outcome 5 is specifically designed to have the validated technologies delivered to stakeholders, with particular targeting of development partners, including developing their capacities to take them to scale – in line with the Phase II core approach "….to broaden our engagement with development partners who, backstopped by target Africa RISING research, will have the capacity to generate impacts at scale by applying Africa RISING innovations". Broad categories of technologies validated to different SIAF domain levels (mainly productivity, economics and environment domains) are given below.

Broad category	**Validated flagship technologies**
Genetic integration involving introduction of new crops and varieties to overcome existing biotic and abiotic stresses	Drought-tolerant maize, groundnut, millet, sorghum
	Climbing bean; nutrient dense beans
	Short-duration pigeon pea
Manipulation of crop ecologies to get more crops on limited land and maximize biological nitrogen fixation	Doubled-up food legumes & mbilimbili
	Doubled-up food and fodder legumes
	Cereal–legume intercropping, crop rotations
Integrated soil fertility management as a cost-effective approach to replenish soil fertility	Optimized fertilizer rates, Composts
	Livestock manure
	Cover crop composts
Introduction of land management technologies to reduce soil loss and enhance water utilization	In-situ water harvesting
	Physical barriers to reduce erosion – "fanya juu", "fanya chini", and shelterbelts
	Cover crops
	Conservation agriculture
Improved livestock feed quality and quantity	Quality forage and fodder based feed rations
	Poultry feeds with vegetable rations, & housing
	Livestock feed with fodder rations
Pre- and postharvest approaches to reduce food waste and improve food safety	Motorized shelling machine, collapsible dryer cases, PICS bags
	Aflasafe application in maize and groundnut fields
	Vegetables

Nutrient-rich food crops for improved household nutrition	Quality protein maize
	Orange-fleshed sweet potato

Planned work for 2018-2019

This workplan has been compiled from those submitted by individual institutions. The presentation is such that each sub-activity has the justification, objectives and/or research questions, experiment design, implementation and data analysis presented in summary formats. Details of these sections are given in the research protocols that are appended.

Outcome 1: Productivity, diversity, and income of crop-livestock systems in selected agro-ecologies enhanced under climate variability

Output: 1.1: Demand-driven, climate-smart, integrated crop-livestock research products (contextualized technologies) for improved productivity, diversified diets, and higher income piloted for specific typologies in target agro-ecologies and scaled in Outcomes 4 and 5

Activity: 1.1.1 Assess and iteratively improve resilient crop-crop and crop-livestock integration systems		
Sub-activity 1.1.1.1 Validate drought tolerant maize (DT) hybrids under on-farm conditions in Kongwa and Kiteto for future integration in crop-livestock production systems		
Research team:		
Name	*Institution*	*Role*
Bright Jumbo	CIMMYT	PI
Elirehema Swai	TARI-Hombolo	Backstop R4D activities
Anicet Sambala	IITA	M&E Support
Francis Muthoni	IITA	Generation of maize variety adaptation maps
Students: Nil		
Locations	Ismani, Igula, Kihorogota, Ndoela, Mlali, Sagara Villages, Kongwa and Kiteto Districts of Tanzania	
Start	October 2017	
End	September 2019	
Justification: Kongwa and Kiteto receive limited rainfall annually with poor distribution. Addition to poor rains, most of the areas in Kongwa and Kiteto have very poor soils, limiting maize yields to average 1.1 tons per hectare each season. Deployment of drought tolerant and high yielding maize hybrids will increase maize productivity under on-farm conditions.		
Objectives: 1. Validate DT hybrids under on-farm conditions for consistence		

2. Determine Genotype x Environment (GxE) effects, adaptability and stability of the new hybrids in the semi-arid areas
Research questions: 1. Is the performance of DT hybrids under on-farm conditions consistent across seasons? 2. Is the season contributing significant genotype x interaction (GxE) effects on hybrid performance across seasons in the semi-arid environments
Experiment design, implementation and data analysis: 12 hybrids (main treatments) plus 3 checks (two commercial hybrids and one local variety) will be tested. The trial will be conducted using a 3 x 5 Alpha lattice design; each treatment planted on two 4 meters long rows plots at a spacing of 0.25m between hills and 0.75m between rows and replicated twice. The trial will be planted at 8 sites. Using yield data in the GGE-biplot analysis, the sites will be grouped according to similarity (mega-environments) to represent agro-ecologies existing in the semi-arid areas of Kongwa and Kiteto. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data to be collected and uploaded on Dataverse:	
SI Domain	**Responsible institute**
Productivity: Yield data measured in kg/ha, biomass measured in kg/ha	CIMMYT
Environmental: Plant biodiversity (# of varieties). Number of maize varieties grown in neighboring fields, Status on levels of major disease and pest	CIMMYT
Economic: Profitability/Gross margins (USD) calculated from the information on production costs and income based on yield data	CIMMYT
Social: Gender equity (technology and variety performance ratings based on gender during field days. Information will be collected during field days on participatory variety selection)	CIMMYT
Human Condition: Knowledge on best hybrids by community/capacity to experiment. Ratings of varieties by farmers (# of farmers by gender desegregation choosing a particular variety). Information can be collected during field days	CIMMYT

Deliverables:	*Means of verification*	*Delivery date*
1. High performing DT hybrids confirmed	Project progress reports, M&E reports	20 Sept. 2019
2. Profitable hybrids identified	Gross margin analysis results	20 Sept. 2019
3. Community participation enhanced & knowledge about best DT hybrids increased	Field day reports	Aug. 2019

4. Hybrid with high biomass identified	Project reports	20 Sept. 2019
5. Status on major disease/pest known	Project reports	30 Aug. 2019

How will scaling be achieved?
Engagement of seed companies & agro dealers through variety release, commercialization and delivery of certified seed to local market outlets accessible by local farming communities in Kongwa and Kiteto**.** Refer to sub-activity 5.2.1.1

How are the activities in this protocol linked to those of others?
To realize hybrid yield potential, good agronomic combined with good soil and water conservation practices are critical. Choice agronomic practices for the new varieties are validated with the S&WC (TARI-Hombolo) and ISFM protocols (SUA). Results from validated agronomic studies and soil and water conservation studies will be packaged together with the output from this study and available for scaling.

Sub-activity: 1.1.1.2
Investigations on the medium to long term impacts of SI technologies (improved soil fertility management, improved germplasm, crop combinations, nutrient and water management) on crop productivity on multi-locational fields sites and baby trials

Research team

Name	*Institution*	*Role*
Regis Chikowo, Sieg Snapp	MSU	PIs, research conceptualization, design, implementation
Julius Manda	IITA	Backstopping on economic evaluation
Gundula Fischer	IITA	Technical backstopping on gender and labor analyses
Anicet Sambala	IITA	M&E Support
Lieven Claessens	IITA	Ex-ante impact assessment with Trade-off Analysis Model for Multi-Dimensional Impact Assessment (TOA-MD) for regional relevance of Africa RISING technologies

Students

Name	*Institute*	*Degree*	*Start*	*End*
Chiwimbo Gwenambira	MSU	PhD Agroecology	2016	2019

Locations	Linthipe, Golomoti, Kandeu, Nsipe, Mtubwi, Nsanama, Nyambi, Ntiya Extension Planning Areas (EPAs) of Malawi
Start	Some sites started 2013; some November 2016
End	November 2019 (Machinga/Mangochi); September 2021 (Dedza/Ntcheu)

Justification:
Integrating more grain legumes as intercrops or rotational system can allow farmers to achieve high and stable yield under varying rainfall, with modest fertilizer investments. This is critical for resource-poor farmers who have limited access to mineral fertilizers. In these experiments that

were initiated in 2012, we investigate SOC changes over time for treatments that range from an unfertilized control, maize fertilized with NP optimally every year and when legumes are integrated as intercrops or rotations with maize. Recently we have applied stability analysis to assess impacts of grain legume integration on maize grain yield, yield stability, nitrogen use efficiency (NUE) and ability to meet household protein requirements

Objective:
Evaluate long-term effects of rotating legumes with maize at multi-location sites, and establish yield stability

Experiment design, implementation and data analysis:
The main driver to this study is increased the productivity of main crops grown in Malawi (maize, soyabean, groundnut and pigeonpea on small farms. This study integrates more grain legumes that are expected to improve soil N economy through biological N2-fixation, and human nutrition through better access to grain legume protein. The experiments are also used to study how farm economics could be improved and track environmental indicators of sustainability such as soil organic carbon. The research protocol describes the crop x intercrop x rotation x fertilizer designs implemented on mother and baby research locations. Over time, an assessment on how farmers expand and implement SI technologies at farm scale is conducted through an annual panel survey that has now been implemented over the past three cropping seasons. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data to be collected and uploaded on dataverse:

SI Domain	**Responsible institution**
Productivity: Maize, soyabean, groundnut, pigeonpea grain productivity (kg/ha/season); maize, soyabean, groundnut, pigeonpea biomass productivity (kg/ha/season); Variability of production (CV); yield gap per crop (kg/ha/season); nitrogen use efficiency (kg grain/kg N applied)	MSU
Environmental: Water availability (soil moisture by treatment); total soil carbon (%SOC); biological N2-fixation estimates (kg/ha N fixed per season); Rating of erosion	MSU
Economic: Profitability of different technologies; Net income ($/crop/ha/season); Gross margin ($/ha/season); Benefit-Cost Ratio; Input use intensity (input kg/ ha); Labor requirement - farmer rating of labor	MSU and IITA
Social: Rating of technologies by gender	MSU and IITA
Human Condition: Nutrition- protein production (g/ha); Food security - food production (calories/ha/year)	MSU

Deliverables	*Means of verification*	*Delivery date*
1. SI Field trials established for each site	List of field trials, host farmer names available	Jan. 2019

2. Baby trials established by at least 3000 farmers experimenting with SI technologies	Farmer lists and SI technologies being implemented in baby trials	Jan. 2019
3. Benefits of SI technologies evaluated across sites	Productivity data files available	Sept. 2019
4. At least one field day per site conducted	Field day reports	Sept. 2019
5. At least 3 farmer exchange visits conducted	Farmer exchange visits reports	Aug. 2019

How will scaling be achieved?

Malawi extension system (District Agricultural Extension Coordinating Committees – DAECC) that has oversite on technology dissemination at district level will help disseminate technologies in Extension Planning Areas (EPAs) that are not physically reached by Africa RISING project. The DAECC constitutes a network that includes district-level government extension system and all NGOs operating in the district. This body harmonizes agricultural technologies dissemination approaches and improves the efficiency of use/allocation of financial resources by different actors in the different EPAs.

How are the activities in this protocol linked to those of others?

Choice of crop varieties has been harmonized based on experiences and technical advice from ICRISAT. For example, groundnut varieties used in this sub-activity and in LUANAR sub-activity B are based on guidance from ICRISAT breeders. Increased productivity of grain legumes based on this sub-activity is directly linked to nutrition studies.

Sub-activity 1.1.1.3

Determining the productivity of groundnut as a function of generation x variety x density interactions in two contrasting agroecologies

Research team:

Name	*Institution*	*Role*
Wezi Mhango	LUANAR	PI, research conceptualization, design, implementation
Regis Chikowo	MSU	Backstop biological N2-fixation methods
Anicet Sambala	IITA	M&E support

Students:

Name	*Institute*	*Degree*	*Start*	*End*
Jester Kalumba	LUANAR	MSc	2017	2019

Locations	Linthipe, Mtubwi, Extension Planning Areas (EPAs) of Malawi
Start date:	Nov. 2017
End date:	Nov. 2019

Justification: Groundnut can fix 20 to 205 kg N/ha, with some of the drivers such as available soil phosphorus, soil pH, temperature, plant density, soil moisture and crop management practices. Plant density is one of the determinants of crop growth and yield. At high densities above optimum, interspecific competition may reduce plant growth and crop productivity. There is variation in above ground plant architecture for different varieties of groundnut and this might influence the level of competition. However, lower densities reduce overall total biomass production per unit area and this has implications on yield as well as nitrogen inputs through biological nitrogen fixation. Plant density is also linked to aflatoxins prevalence and intensity.		
Objective: Evaluate the effect of seed quality and plant density on the yield and biological nitrogen fixation of groundnut in two agro ecological zones.		
Experiment design, implementation and data analysis: Two researcher designed-farmer managed groundnut on-farm trials will be conducted in two contrasting ecological zones of Dedza district (Linthipe EPA) and Machinga district (Mtubwi EPA). Linthipe EPA is on high altitude, receives more rainfall above 1200 mm per annum while Mtubwi EPA lies in the low altitude area, with high average temperatures and evapotranspiration and receives less rainfall around 600 mm. In each EPA, the treatments will be laid out in a split-split plot following randomized block design, replicated four times. Main plot factor will be planting density while variety and seed generation will constitute two subplot factors. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.		
Data to be collected and uploaded on Dataverse		
SI Domain	**Responsible institution**	
Productivity: Groundnut grain productivity (kg/ha/season); groundnut biomass productivity (kg/ha/season)	LUANAR	
Environmental: Soil chemical quality: Biological N2-fixation estimates (kg/ha N per season)	LUANAR	
Economic: Profitability of different technologies (Gross margin) in $/ha, Benefit-Cost Ratio	LUANAR	
Social: Rating of technologies by gender (see survey S1)	LUANAR and MSU	
Human Condition: Nutrition: Protein production (g/ha), Food safety: aflatoxins (micrograms/kg)	LUANAR	
Deliverables	*Means of verification*	*Delivery date*
At least one field trial established in Linthipe and Ntubwi Site description details (soils, seasonal rainfall)	Trial establishment protocol and report	February 2019
Density x variety x seed generation assessed	Technical report	September 2019

At least 5,000 farmers in Dedza and Machinga adopting double-row cropping of groundnut	Internal reports from Dedza and Machinga DADO offices	September 2019
MSc thesis	Thesis submitted	September 2019

How will scaling be achieved?
LUANAR participates in the Malawi agricultural technology assessment committee. Information from these trials will be discussed at this level for uptake by different stakeholders with interest in groundnut production and associated value chains

How are the activities in this protocol linked to those of others?
NA

Sub-activity 1.1.1.4
Exploring the dynamics of indigenous goat performance under intensive crop-livestock management integration in Malawi

Research team:

Name	*Institution*	*Role*
Fanny Chigwa	LUANAR	PI, research conceptualization, design, implementation
Regis Chikowo	MSU	Logistical support
Gundula Fischer	IITA	Gender analysis
Anicet Sambala	IITA	M&E support

Students

Name	*Institute*	*Degree*	*Start*	*End*
Dyton Maselema	LUANAR	MSc Animal Science	2018	2020

Locations	Linthipe, Mtubwi, Extension Planning Areas (EPAs)
Start date	November 2017
End date	November 2020

Justification:
Goats in Malawi usually rely on browsing and sometimes grazing in the lowlands whereas in the highlands, they survive on communal grazing and crop residues. This management system generally predisposes crops in the field to damage by the goats. Goats are particularly attracted to pigeon peas and cassava plants, which remain in the field post maize harvest period (July to August). Intensification of goat production in smallholder areas could provide a solution to the livestock-crop conflict for land and water resources which has been exacerbated by increasing population pressure. Tools for intensification include the use of pen feeding based on locally available feed resources. In addition, by intensifying goat production, goat product quantity and quality may be improved to meet consumers' expectation and profitability.

Objectives:
To explore the tradeoffs of using different goat management systems
To evaluate the effect of different goat management systems on animal performance
To evaluate the effect of different dietary treatments based on bean pods, pigeon peas or *Faidherbia albida* pods on animal performance
To evaluate the profitability of raising goats under different management systems

Experiment design, implementation and data analysis:
The study will be laid in a block design involving five farmer groups. Each farmer group will have three subclusters with each having three farmers. The three subclusters will each have each of the three treatment. The subclusters will be identical. The farmers will participate in treatment allocation and monitoring of progress. The treatments will be Treatment 1= Pen feeding, Treatment 2 = herding, and Treatment 3 = free range grazing. Each of the farmers will be a replicate for each group. The treatments will have 5 *3*3 =45 farmers. Each farmer group will have nine goats of the same age. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on dataverse:

SI Domain	**Responsible institution**
Productivity: Animal Productivity: Daily growth rate of goats (g/day), goat meat production (amt./animal/yr); Rating of animal productivity	LUANAR
Environmental: Animal by-product (manure quality, %N content)	LUANAR
Economic: Labor requirement: Farmer rating of labor (labor input of pen feeding and group herding compared to each farmer herding own goats)	LUANAR
Social: Equity: Rating of technologies by gender	LUANAR and IITA
Human Condition: Nutrition: protein production (extra goat protein/feeding duration)	LUANAR

Deliverables:	*Means of verification*	*End date*
Goat feeding trials established	Protocol available	March 2019
Weight gain established	Technical report	September 2019
Breeding goats delivered to communities	Breeding goats available in Linthipe and Ntubwi EPAs	April 2019
MSc thesis	Draft chapters completed	September 2019

How will scaling be achieved?
Malawi extension system at district level (the District Agricultural Extension Coordinating Committees – DAECC) is a prime vehicle for disseminating improved goat rearing technologies to other EPAs and districts.

How are the activities in this protocol linked to those of others?

NA

Sub-activity 1.1.1.5
Determining the productivity and resilience benefits of Gliricidia-based cropping systems

Research team:

Name	*Institution*	*Role*
Anthony Kimaro	ICRAF	PI, research design and oversight of project activities
Emmanuel Temu	ICRAF	Socio-economic, gender and labor studies
Julius Manda	IITA	Technical backstopping on economic analyses
Gundula Fischer	IITA	Technical backstopping on gender and labor analyses
Francis Muthoni	IITA	Technical support on GIS-based soil erosion mapping
Anicet Sambala	IITA	M&E Support

Students:

Name	*Institute*	*Degree*	*Start*	*End*
Lean Renwick	UC Davis	PhD	2019	2019 (work in Tanzania)
J. Hafner	Humboldt	PhD	2018	2019 (work in Tanzania)

Locations:	Manyusi, Mlali and Molet villages in Kongwa District of Tanzania
Start date:	October 2017
End date:	September 2021

Justification:
The doubled-up legume trials were established in 2015 and assessed for crops yield (Maize and pigeonpea grain) for first 3 seasons in 2015-2017. It was noted that intercropping maize with G. sepium and pigeonpea improved crop yields (maize and pigeonpea) up to 33%, but with variable seasonal variations because this was the establishment phase when tree effects on soil conditions and microclimate modification were building up. This study will continue to evaluate the resilience value of the Gliricidia-based doubled up legume technology as a climate smart technology for semiarid areas based on the complete assessment of the technology using the SIAF approach, and on a longer-term basis. An expanded description of the justification is given in the Research Protocols 2018-2019 – Appendix 1.

Objectives:
To assess long-term crop yield, resource use efficiency and resilience effects of the doubled-up legume system in semi-arid areas under researcher- and farmer-managed conditions
To evaluate socioeconomic benefits and gender aspects of the double up legume technology

Experiment design, implementation and data analysis:
During 2015, the experiment was laid out in a randomized complete block design (RCBD) with 3 replications and five treatments (Pure stands of maize and pigeonpea, maize intercropped with *G. sepium*, and intercropping of maize, pigeonpea and *G. sepium*). Starting the 2019 season, each plot will be split into half (converting the design into a split-plot) to impose the drought stress

treatment at the onset of the active growth period of maize. Drought will be simulated using the above-canopy rainout shelters with a slatted roof that intercepts 50% of the ambient rainfall, transmits 95% of photosynthetically active radiation (PAR), and minimally affects air temperature below the shelter. Thus, the whole plot factor will be rainout shelters (with and without rainout shelters) and the sub-plot factor will be intercropping arrangements. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on Dataverse:

SI Domain	**Responsible institution**
Productivity: Crop Productivity: Maize grain and stover yield (t/ha/yr); wood and foliage biomass (t/ha/yr)	ICRAF
Environmental: Soil carbon (g/kg-soil); Soil moisture (%), Rainwater use efficiency (kg/mm/yr); Nutrient uptake (kg/ha); Nutrient use efficiency (kg/uptake); weather data; GPS points	ICRAF and SUA (Shitindi)
Economic: Gross margin in USD/ha; Benefit-Cost Ratio-BCR;	ICRAF and IITA (Kotu)
Social: Food availability (number of food sufficiency month per household/year)	ICRAF
Human Condition: Perception of benefits of the technology by gender	ICRAF and IITA (Gundula)

Deliverables	*Means of verification*	*Delivery date*
At least 50 farmers are mobilized and engaged in validating *G. sepium* intercropping in baby trials	Progress report	April 2019
Co-organized farmer field day and Nane-nane exhibition	Activity & progress reports	May and August, 2019
Yield (crops and biomass) and resilience benefits of *G. sepium-based cropping systems* intercropping determined	Progress report	August 2019
Economic benefits of *G. sepium* intercropping evaluated	Progress report	August 2019
Gender analysis of at least 50 farmers	Progress report	August 2019

How will scaling be achieved?

ICRAF will work with Dorcas Group at Mlali, TANAPA (Kilosa), Extension officers and DAICOs to deliver at least at least 10,000 seedlings and agroforestry education to non-AR sites (e.g., Ngumbi and Kitete Msindazi villages)

How are the activities in this protocol linked to those of others?

Test crop (Maize variety and pigeonpea) used in this trial are promising variety selected by ICRISAT and CIMMYT. *G. sepium* fodder is used in pen goat feeding trials in Malawi and similar work can be adopted for Kongwa for draught animals, which needs supplementary feeding for high productivity. Also used in poultry feeds in the KK/Babati poultry feed experiments.

Sub-activity 1.1.1.6
Assess the yield, economic and BNF benefits of innovative approaches addressing the pigeon pea and common bean productivity within maize-based cropping system and variable weather

Research team:

Name	*Institution*	*Role*
Job Kihara	CIAT	PI
Ben Lukuyu	ILRI	Determination of residue quality and impact (feeding days)
Jonas Rose	MoA	Organize field days and supervise field operations by farmers
Anicet Sambala	IITA	M&E Support

Students: NIL

Locations	Seloto, Sabilo, Orngadida villages of Babati District, Tanzania
Start date	Jan 2017
End date	Nov 2020

Justification:
In Babati, research work by Africa RISING has developed practices that increase productivity of maize. However, the legume (both beans and pigeonpea) remain of low productivity. To maximize on the productivity and profitability of the system, increasing legume productivity is important. This can be achieved through various technologies that is increase light access to the legume. The CIMMYT tested and proven maize varieties such as Meru 513 that has vertical architecture could lead to increased yield of intercropped legume through increased light access to legume. Complementary practices like maize topping, stripping of lower leaves and planting maize as 2 rows closer to each other (spacing of 50 cm) leaving a large space before the next 2 maize rows also increase light penetration, creating favourable conditions for intercropped legumes in a doubled-up system like that successfully tested in Malawi. An expanded description of the justification is given in the Research Protocols 2018-2019 – Appendix 1.

Objectives:
1. Assessing the effects of different crop spatial configurations on productivity of pigeon pea and beans within in 3 eco-zones of Babati, Tanzania
2. To determine nitrogen fixation within the maize-legume systems in 3 eco-zones of Babati

Research questions:
1. What are effects of different crop spatial configurations on productivity of pigeon pea and beans within in 3 eco-zones of Babati, Tanzania and
2. To what extent does the legume integration contribute to nitrogen fixation within the maize-legume systems in 3 eco-zones of Babati

Experiment design, implementation and data analysis:
The experiment is laid out as a randomized complete block design with 7 maize-legume intercrop treatments. In each field, each treatment is replicated 3 times. Treatment plot size are 7m x 5m. The net plot used for measurements of grain and biomass will leave out 1 m from each side of the plot to reduce border effects. Except for one treatment with a 50x90 maize spacing, two maize seeds will be planted at a spacing of 25 × 75 cm, and later thinned to one, to attain a plant

population of 53333 plants per hectare. Pigeon pea and beans are planted to also attain similar densities across plots (i.e., the Mbili-Mbili system has the same pigeon pea density as in other maize-pigeon pea treatments). The research protocol gives details on the treatments, trial design and data collection and analysis. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.		
Data to be collected and uploaded on Dataverse		
SI Domain		**Responsible institution**
Productivity: Crop productivity and crop biomass productivity **(**Residue production at plot level during stripping and topping and final harvest). Maize residue production at plot level during stripping and topping (kg/ha/season) Maize grain yield (kg/ha/season). Maize stover yield at harvest (kg/ha/season) Pigeon pea grain yield (kg/ha/year)		CIAT/MoA/ILRI
Environmental: Soil chemical quality: Biological nitrogen fixation at plot level (kg N ha^{-1} $season^{-1}$) Fuel availability: (fuel biomass i.e., wood produced at plot level (kg ha^{-1} $season^{-1}$) Soil chemical quality (pH and nutrient levels) Soil physical properties (soil moisture) at plot level (m^3m^{-3}) Infiltration rates at field level ($cmsec^{-1}$) Light interception at plot level		CIAT/MoA
Economic: Profitability: gross margin at plot level Gross margin at plot level ($/crop/ha/season) Labour requirement (farmer rating of labour).		CIAT/ ILRI/TARILI
Social: Gender equity (Rating of technologies by gender) Rating of technologies by gender (% change)		CIAT/MoA
Deliverables	*Means of verification*	*Delivery date*
6 on-farm trials, 2 in each of 3 eco-zones, successfully Implemented	Research reports	October 2019
3 new technologies introduced and tested	Research reports	October 2019
BNF of pigeon pea quantified	Research reports	November 2019
150 farmers trained (in field days)	Field day reports	October 2019
How will scaling be achieved? Partnership with Meru Agro Seed Company to deliver Improved maize seeds and provide advice to farmers, with World Vision and with Cosita to potentially utilize Mwanga ICT platform in		

communication of agronomic information. Besides, farmers already enlisted in Mwanga will receive monthly agronomic messages.

How are the activities in this protocol linked to those of others?

ILRI and TARILI utilize residues from toppings and strippings for livestock. Double-up legumes also contained in protocols for Kongwa-Kiteto and Malawi. We are utilizing Mwanga ICT, a tool developed within Africa RISING.

Sub-activity 1.1.1.7

Monitoring the impact of weather and climate variability on the productivity and resilience of maize – legume cropping systems of Kongwa and Kiteto, Tanzania.

Research team:

Name	*Institution*	*Role*
Mawazo J. Shitindi	SUA	PI, designing and leading the research, supervising graduate student and overseeing the project activities
Francis Muthoni	IITA	Modelling the impact of weather variability on performance and resilience of maize legume-based cropping systems
Anthon Kimaro	ICRAF	Providing historical maize and legume productivity and resilience data from Gliricidia-based cropping systems
Elirehema Swai	TARI Hombolo	Providing historical maize - legume productivity data from soil water management technologies
	ICRISAT	Source of pigeon peas and groundnut varieties for research
DAICO’s	Kongwa and Kiteto DC.	Back stopping of maize legume – historical productivity data for modelling
Anicet Sambala	IITA	M&E Support.

Students:

Name	*Institute*	*Degree*	*Start*	*End*
Mushi Revocatus	SUA	MSc. Soil Science and Land Management	Jan. 2019	Nov. 2021

Locations:	Mlali village of Kongwa district and Njoro village of Kiteto District
Start date	2018 - new sub activity building on what has been done by TARI and ICRAF since 2014
End date	2021

Justification:

The impact of weather and climate variability and change is more remarkable on rain-fed agriculture in the arid and semiarid lands. In Tanzania, rainfall has significantly decreased in the recent years, and further rainfall decrease is expected by the mid of this century. Positive correlation is reported between weather variability and crop yields under the rain-fed agriculture. For example, 20% increase in intra seasonal precipitation variability has been reported to reduce yields of maize, sorghum and rice by 4.2%, 7.2%, and 7.6%, respectively (Rowhani et al., 2011). Assessment of the effects of weather and climate variability on agriculture and environment is thus worthwhile in order to design proper adaptation and mitigation measures that improve resilience

(IPCC 2014. Weather data for such an assessment in semi-arid areas of Kongwa and Kiteto is scanty and unreliable. With newly installed weather stations, monitoring of key weather variables will be undertaken, as well as establishing the correlation between weather variability and productivity of maize – legume cropping systems and modelling the impact of weather variability on future productivity and resilience of maize legumes cropping systems for informed decision making.

Objectives:
Monitor the variability of key weather elements and establish the effect of short- and long-term weather variability on the productivity of maize – legume cropping systems in the semi-arid central Tanzania

Experiment design, implementation and data analysis:
Key weather variables (rainfall, temperature, evapotranspiration, relative humidity, solar radiation, wind direction and wind speed, will be automatically recorded using Watchdog 2000 series automatic weather station installed at Mlali and Njolo villages and off-loaded once every month. Daily, monthly and annual ranges will be computed to establish the trends. For monitoring weather variability, historical weather data for ten or more seasons will be obtained from satellite platforms. Respective crop yield data will be collected from research works previously conducted in the two sites for modeling the effect of weather and climate variability on crop yields. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on Dataverse

SI Domains	**Responsible institution**
Productivity: Historical and current maize, pigeon peas and ground nut grain and Stover or wood yield (t/ha/yr)	SUA
Environmental: Variability of key weather elements including rainfall (mm/day/week/month/season/year); Rainfall distribution (Number of rain days/ weeks/months in a season or year); Maximum and minimum temperature (^{o}C); Daily, monthly and annual temperature range (^{o}C), photosynthetically active radiation (PAR)	SUA & IITA
Economic: Profitability (gross margin in USD/ha) associated with variability of weather elements.	SUA
Social: Gender perception of weather variability and associated impacts on crop productivity	IITA
Human Condition: Food availability (number of food sufficiency month per household/year)	SUA

Deliverables	*Means of verification*	*Delivery date*
Historical weather and crop yield data	Data sets	March, 2019
The level of understanding of weather/climate variability and associated impacts on cereal and legume production	Survey report	April, 2019

among the communities in Kongwa and Kiteto districts established		
One automated weather station installed in each research site (Kongwa and Kiteto) and current weather is recorded on monthly basis	Monthly weather data	December 2018 – August 2019
At least 12 lead farmers, 3 extension workers and 2 research assistants trained on the use of automated weather stations, weather/climate variability and mitigation of associated impacts on crop production.	Training report	June 2019
Variability of weather/climate and associated impacts on the yield of maize, pigeon peas and other food legumes traced in Kongwa and Kiteto.	Weather variability and crop yield data sets	August 2019

How will scaling be achieved?

Partnership with District Agricultural and Livestock Development offices (DAICOs), TMA and agricultural based NGOs

How are the activities in this protocol linked to those of others?

Choice crop varieties for testing the impact of weather variability on crop yield are validated with crop improvement (ICRISAT) and agronomic practices for the new varieties are validated with the S&WC (TARI Hombolo).

Activity: 1.1.2

Evaluate and implement pathways that are effective at improving access to seeds and clonal materials of modern varieties of legumes, cereals, vegetables, forages and livestock

Sub-activity 1.1.2.1

Assessment of the benefits of management technologies on performance of improved vegetable varieties

Research team:

Name	Institution	Role
Justus Ochieng	WorldVeg	PI
Ludovic Joly	Iles de Paix (IDP)	Fund and facilitate establishment of research trials and backstopping on vegetable technologies.
Francis Muthoni	IITA	Produce regionally relevant extrapolation domain maps for validated vegetables technologies.
Anicet Sambala	IITA	M&E support.

Students: Nil

Location(s):	8 Villages in Karatu District, Tanzania: Kambi ya samba, Bashay, Buger, Gyekrumlambo, Slahhamo, Rhotia Kainam, Chem Chem, Changarawe
Start date	January 2019
End date	October 2019

Justification:

Vegetables are valuable sources of energy, micronutrients and income generation for rural and urban population. Traditional vegetables are particularly important for providing micronutrients and are well adapted to harsh climatic conditions and diseases infestation and are easier to grow. However, low production per unit area is the major challenge. Declining yield of vegetables is as a result of poor farming practices such as use of poor-quality seeds, poorly sown and managed seedlings and inadequate application of manures, limited water for production, misuse and abuse of inorganic fertilizers, and rampant use of pesticides.

Improved management practices (IM), combines technological packages of good quality improved seed varieties, healthy seedlings, good agronomic practices (GAPs), can potentially provide pathways out of hunger and poverty. The current research is based on the premise that growing improved vegetable varieties may be promoted when combined with improved and safer practices that will contribute to diverse, healthier and balanced diets while also increasing farm household income.

Objectives:

1. To introduce improved vegetable varieties to farmers who predominantly grow staples.
2. To assess the impact of improved management practices on yield, reduction insect pests and profitability of growing different vegetables (e.g African nightshade, tomato and Ethiopian mustard).
3. To build the capacity of staff of IDP, a development partner, to scale out the technologies in other regions.

Experiment design, implementation and data analysis:

The study will follow on farm participatory research approach. Each experiment will be a Randomized Complete Block Design (RCBD) which makes it easy to conduct experiments with farmers and scale up the technologies. The experiment will be replicated in 8 villages over two seasons. The treatments will include 3 improved crop varieties X management (+/- improved management practices). An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on Dataverse

SI Domain	**Responsible institution**
Productivity: Crop productivity: Vegetable yield at plot level (kg/ha/season) Data to be collected: Yield per crop, Date of flowering and maturity, Number of plants harvested	WorldVeg
Economic: Profitability: Gross margin/CBA at plot level ($/crop/ha/season) Data to be collected: Labour input in hours per week, costs of inputs (staking for tomato, water, fertilizers, seeds, harvesting, etc.), price of each marketable crop	WorldVeg
Environmental: Pest levels: Pest abundance and severity by type; Pesticide use: active ingredient applied (kg/ha) Data to be collected: Pest management data (see protocol)	WorldVeg

Human Condition: Nutrition: Access to nutritious foods- Amount of vegetable consumption per capita (g/day) Vegetable consumption diversity (no. consumed per day) Data to be collected: Number of types of vegetables consumed and amount consumed in 7 days	WorldVeg
Social: Gender equity: Rating technologies by gender Technology ratings by men and women through FGD	WorldVeg

Deliverables	*Means of verification*	*Delivery date*
Performance (Yield and profitability) of vegetable production using improved technologies in Karatu established	Report on performance of the research trials	September 2019
At least 128 lead farmers, 8 government extension officers and 3 partner (NGO) staff trained on safe production of vegetables	Training report	June 2019
Two farmer field days conducted	Farmer field day reports	April 2019 & September 2019
At least 1 success/blog story	Success story submitted to Africa RISING Comms.	September 2019

How will scaling be achieved?
Islands of Peace (IoP), an NGO in Karatu District, will scale the technologies to an estimated membership of 450 households within Karatu district and to other regions where they are conducting development activities.

How are the activities in this protocol linked to those of others?
Good agronomic practices for new traditional African vegetables (TAV) varieties are being validated elsewhere by Mboga na Matunda (MnM) project led by WorldVeg and TAHA in Zanzibar. The Livestock component of the ESA Project are utilizing vegetable wastes for feeding poultry.

Sub-activity 1.1.2.2
Assess the efficacy of a net house and biopesticides in controlling *Bemisia tabaci* and *Tuta absoluta* on, and promoting access to new solanaceous vegetables

Research team:

Name	*Institution*	*Role*
Justus Ochieng	WorldVeg	PI
Anicet Sambala	IITA	M&E Support

Students: Nil

Locations:	Shaurimoyo, Bermi and Matufa villages, Babati District, Tanzania

Start date	2017	
End date	2019	
Justification: Common vegetables produced in Tanzania are solanaceous ones, particularly pepper (*Capsicum annuum*) and tomato (*Solanum lycopersicum*) which enjoy high market demand. However, cultivation of tomato and pepper is constrained by pests especially *Tuta absoluta.* Cultivation of sweet pepper is also constrained by sucking insects including *Bemisia tabaci* (whitefly). Management of these pests by chemical pesticides is economically and environmentally unfordable due to resistance and/or complexity of growth stages.This study will evaluate the efficacy of net houses and a biopesticide (*Metarhizium anisopliae*) against whitefly (*Bemisia tabaci*) and the tomato leafminer (*Tuta absoluta*) with farmers in Babati distrit.		
Objectives: To evaluate efficacy of low-cost net house in combination with biopesticide for control of pests on new vegetables varieties to improve health and income of small holder farmers.		
Experiment design, implementation and data analysis: The study will follow Randomized Complete Block Design (RCBD). Tomato variety (Tengeru 2010) and Sweet pepper (Yolo wonder) will be evaluated. The experiment will be conducted in three villages of Babati District (Matufa, Shaurimoyo and Bermi) under open field and net house conditions in each location. Each plot will consist 20 plants per treatment. Commercial biopesticide (*Metarhizium anisopliae*) will be applied in all biopesticide treatments, contrasting with a control where water containing 1% dispensing agent will be applied. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.		
Data (with metrics) to be collected and uploaded on Dataverse		
SI Domain		**Responsible institution**
Crop productivity: Vegetable yield (kg/ha/season) Data to be collected: Yield per crop, Date of flowering and maturity, Number of plants harvested.		WorldVeg
Economic*:* Profitability: Gross margin at plot level ($/ha/season) Data to be collected: Labour input in hours per week, costs of inputs (staking for tomato, water, fertilizers, seeds, harvesting, etc.), price of each marketable crop		WorldVeg
Environmental: Pesticide use: active ingredient applied (kg/ha) Pest levels: pest abundance and severity by type		WorldVeg
Social: Gender equity: Rating of technologies by gender Data to be collected: Technology ratings by men and women through focus group discussion (FDG)		WorldVeg
Deliverables:	*Means of verification*	*Delivery date*

Performance (Productivity and economic) of vegetable production using improved technologies (Net house and bio pesticides).	Report on performance of the research trials	August 2019
At least 50 farmers trained directly, 4 government extension officers and partner staff trained on the two technologies	Training report	June 2019
1 farmer field day conducted	Farmer field day report	May 2019
Draft journal article	Draft article submitted to the Africa RISING chief scientist	September 2019

How will scaling be achieved?

Friends in Development Trust Fund (FIDE) will scale the technologies in Babati where they have activities. IDP will also scale the technologies to progressive farmers in Karatu that will be identified.

Sub-activity 1.1.2.3

Conduct integrated community breeding and management studies for poultry

Research team:

Name	*Institution*	*Role*
Chrispinus Rubanza	The University of Dodoma (UDOM)	PI and chicken breeding
Edward Moto	UDOM	Chicken molecular studies
Faustine Kashumba	UDOM	Socio-economic/Community livelihoods
	DAICOs offices	Backstop R4D activities
Anicet Sambala	IITA	M&E Support

Students: Nil

Locations:	Mlali- Kongwa; Mwanya-Kiteto; Galapo, Dareda and Matufa, Babati, Tanzania
Start date	December 2014.
End date	December 2021.

Justification:

Studies conducted during the immediate previous years have shown that:

- There are phenotypic and genetic variations in both qualitative and economic traits of local chicken ecotypes across sites
- Local chicken- meat type crossbreds weighing 3.0-3.5 for hens and 4.0-4.5 kg can be achieved through crossbreeding
- The crossbreds have high egg-laying potential.
- Project farmers have been able to produce and supply chicks to fellow farmers and elsewhere outside the project.

- There is needed to further generate breeding information that is necessary for enhancing community-led chicken breeding and multiplication.

Objectives:

- To test and validate performance (hatchability, chick survival, growth rate, body weight and other qualitative and quantitative traits) of chicken crossbreds compared to their local ecotypes/ sub-ecotypes, commercial dual purpose and pure meat strains
- To test and validate the potential of community chicken breeding model as a source of chicks/ chicken growers
- To determine egg physical and chemical parameters of chicken crossbreds
- To assess the socio-economic contribution of chicken crossbreds
- To Assess the impact of introducing chicken crossbreds on livelihoods in the study sites

Experiment design, implementation and data analysis:

A mixed experimental design will be deployed consisting of:

I. Completely randomised block design where the three districts (Babati, Kongwa and Kiteto) will each be treated as individual blocks whose main variants are farmer variables. The main treatments will be 5 chicken strains (Kuchi, Kroiler, Sasso, Rhode Island Red and Africa RISING Project Offsprings)

II. A Nested Model to evaluate the genetic performance (egg number, % hatchability, chick survival, chick growth) rate will be nested within their dams (hens) and sires (cocks).

III. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on dataverse

SI Domains	**Responsible Institution**
Productivity: Livestock Productivity Number of eggs per chicken flock per year Per cent egg hatchability (%) per chicken flock per year Growth rate/ rate of gain (g/d/year) Body weight (kg/ chicken; kg/ strain); Egg weight (g/egg) Egg quality (albumen weight, yolk weight, yolk colour, eggshell weight, egg thickness) Meat weight/chicken/ strain, meat colour, meat taste, meat aroma, meat juiciness Survival rate- number of surviving individuals per birth	UDOM
Environmental: Pesticide use Active ingredient applied per bird Diseases resistance, incidence and severity. Survival rate- number of surviving individual chicks/ chickens per birth.	UDOM
Economic: Profitability Cost-benefit analysis of the household chicken projects Total poultry profit per households. Diversification index for all marketable poultry enterprises.	UDOM

Diversification index for all poultry income-based household activities. Number of output/unit-input of poultry-based enterprises in each household under the Project compared to non-project chicken keeping households. Market participation in terms of % of poultry production sold at household level. % of total income generated from chicken- based activities.	
Social: Gender equity Improved household income through involvement of women in poultry keeping compared to men. % labour for power vs. control activities at household level Gender roles across sex in poultry keeping. Gender roles in decision making about poultry production and marketing at household level. Level of social cohesion in terms of household participation in community chicken management activities as influenced by gender. Number of Active farmer groups in terms of Improved social networks through farmers' groups that improve women and youth participation in poultry projects Contribution of gender on community chicken management. Variability and distribution of productivity, income and assets at household level across men and women.	UDOM
Human Condition*: Nutrition and Food security* Protein produced (kg/farm) and meat-protein intake and egg- protein intake. Food consumption score (7-days recall of frequency of food types). Frequency of consumption of egg-protein- and meat- protein- based diets/ recipes. Farmers' perceptions of the introduced chicken strains/ breeds. Adoption rate of the introduced chicken ecotypes/ crossbreds. Animal (egg and meat protein) intake/household/week Reduced social conflicts due to income- generation from chicken- based projects across gender.	UDOM

Deliverables:	*Means of verification*	*Delivery date*
3- community chicken breeding models established and tested in each of Galapo, Dareda and Matufa (Babati), Mlali (Kongwa) and Mwanya (Kiteto) action sites	• Field report • Project progress report	February 2019
4 local chicken ecotypes domesticated and evaluated across at least three action sites in Kongwa, Kiteto and Babati districts	• Field survey report	June 2019
At least 2 chicken crossbreds developed, and their performance tested across at least three action sites in Kongwa, Kiteto and Babati districts	• Filed report	April 2019
At least 1 local chicken- meat strain chicken ecotype developed and evaluated	• Field report and progress report	April 2019
A sample of chicken qualitative traits based on plumage colour, body shape/ conformity, comb type, comb shape, ear lobe shape, ear lobe colour, beak type and shape, eye colour are established	• Field report • Project progress report	March 2019

Samples of chicken quantitative traits associated with physical characteristics (body weight, body length, shank length, shank colour) are quantified	• Field report • Project progress report	May 2019
Analyzed report on egg quality based on physical characteristics (egg weight, shell weight, shell colour, shell strength, albumen weight, yolk weight, yolk colour) of 100 chicken from every 3 trains for physical characteristics are established halfway project operation	• Field report • Project progress report	March 2019
A sample of egg quality based on chemical characteristics (albumen pH, albumen protein, yolk protein, mineral composition) of 200 chicken from each 3 chicken ecotypes is established	• Laboratory report • Field report • Project progress report	June 2019
Number of eggs sold at household level at the end of project operation is increased from the current.	• Field report	June 2019
Number of chicks produced at household level at the end of project operation is increased from the current.	• Field report	May 2019
At least number of chickens domesticated at household level at the end of project operation is increased from the current.	• Field report	March 2019
At least 20 women from each of the participating 5 action sites are involved in poultry keeping.	• Field report	March 2019
The income of about 20-30 farmers in each of the 5 action sites is improved through chicken keeping.	• Field report	August 2019
About 20-30 households from each participating 5 action sites have increased egg-protein/meat-protein intake.	• Field report	June 2019
Amount of money used in poultry disease treatment is reduced from current after project operation	• Household income performance reports	April 2019
Poultry housing and practices of about 20-30 farmers from each 5 action sites are improved.	• Field report	August 2019

How will scaling be achieved?

- Partnership with the respective districts' councils for Kongwa, Kiteto and Babati districts
- Partnership with AKTM Company for Kuroiler birds egg/meat chicken strain
- Partnership with Silverland Tanzania for Sasso egg/meat chicken strain

How are the activities in this protocol linked to those of others?

- Integrated community chicken breeding and the local-exotic chicken crossbreds that will be developed and tested across the action sites in the three districts are validated by the feeding trial (ILRI),
- Eggs quality, egg and meat intake are linked to the SUA nutrition Cohort study among lactating mothers and five- year old children.
- Production of chicken manure and their utilization for soil fertility improvement linked to soil fertility improvement

Output 1.2: Demand-driven, labor-saving and gender-sensitive research products to reduce drudgery while increasing labor efficiency in the production cycle piloted for relevant typologies in target areas [and scaled in Outcomes 4 and 5]

Activity 1.2.1: Support local partners through training on appropriate drudgery-reducing technology delivery

No sub-activity planned for this year. Post-harvest threshers and feed chopper/mixer training activities have been conducted before.

Activity 1.2.2: Co-adapt existing mechanization options with target communities

1.2.2.1: Use of tractor mounted ripper tillage implement for enhancing soil water infiltration and moisture conservation in semi-arid areas of Kiteto

Research team:

Name	*Institution*	*Role*
Elirehema Swai	TARI Hombolo	PI: Responsible for research design and project oversight
Gundula Fischer	IITA	Gender analysis and farmers perceptions
Julius Manda	IITA	Backstopping UDOM economist
Mawazo Shitindi	Sokoine University of Agriculture	Technical support on the soil fertility status
Lutengano Edward Mwinuka	University of Dodoma	Economics data collection & analysis
Christopher Mutungi	IITA	Responsible for human condition SI domain
Anicet Sambala	IITA	M&E Support

Students:	Nil
Locations:	Kiperesa village, Kiteto District, Tanzania
Start date	2016/2017
End date	Sept 2021

Justification:

Productivity performance of rip tillage was evaluated during the 2016/2017 cropping season in Njoro and Kiperesa villages. Performance of maize increased by over 30%. However, key information related to human condition, economic, social, environment domains was not fully examined and are being targeted in this study. An expanded description of the justification is given in the Research Protocols 2018-2019 – Appendix 1.

Objectives:

i) Determine the potential benefits of rip tillage in semi-arid agro-ecologies of Central Tanzania in the face of climate variability and in terms of economic gain, labor requirements and soil moisture conservation.
ii) Determine the gender-based value of tractor mounted rip tillage.

Experiment design, implementation and data analysis:		
Trials will be arranged in a mother-baby set up during 2018/2019 cropping season; the baby trials allow wide exposure that enable appropriate socio-economic study conditions. The mother factorial experiment will be arranged in a Split-plot design with two tillage treatments: Conventional farmer practice (CFP) and Rip tillage (RT) and two improved maize varieties (commercial maize variety & DT maize Variety) thus giving a total of four treatment combinations in each participating village. All treatments will receive 20kg of P/ha of Diammonium Phosphate (DAP) fertilizer at planting and (40 kg N/ha) of Urea fertilizer will be applied as a topdressing. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.		
Data (with metrics) to be collected and uploaded on Dataverse:		
SI Domains		**Responsible institution**
Productivity Crop productivity: Maize grain yield (kg/ha/season) Crop biomass productivity: Maize stover yield (kg/ha/season)		TARI Hombolo
Environment Soil physical quality: Soil bulk density (g/cm^3); cumulative infiltration (mm); soil moisture content (%); rainwater use efficiency (kg/mm/yr); water productivity.		TARI Hombolo and SUA Morogoro
Economic Profitability: Gross margin (USD/ha).		University of Dodoma/IITA
Social Farmers perception on use of rip tillage technology segregated by gender		IITA
Human Condition Nutrition : Protein production (g/ha); micronutrient production (g/ha)		IITA
Deliverables:	*Means of verification*	*Delivery date*
Four mother trials and 10 baby trials under rip tillage technique using tractor mounted ripper established in Kiteto District Council	Quarterly report	February 2019
Socio-economic benefits of using rip tillage (tractor mounted ripper) technology segregated by gender established	Progress Report	Sept 2019
Accrued benefits on productivity, environment, and social domains associated with the use of rip tillage technology quantified in semi-arid zones of Kiteto in Manyara Region	Progress Report	Sept 2019
Effect of rip tillage techniques on protein content, micronutrient content, and food safety established	Progress Report	Sept 2019
Farmer field days conducted on at least two mother trials	Field day report	May 2019
How will scaling be achieved? Through engagement of ward/village extension officers and councillors of Kiteto District.		
How are the activities in this protocol linked to those of others? The rip tillage technology is being validated with improved drought-tolerant maize variety (CIMMYT) as test crops.		

Output 1.3: Tools (including ICT-based) and approaches for disseminating recommendations in relation to above research products, integrated in capacity development [and used in Outcomes 4 and 5]

Activity 1.3.1: Conduct extrapolation domain analysis based on GIS, agro-ecology, and crop model-generated information to establish the potential of technologies for geographical reach		
Sub-activity 1.3.1.1: Farmer/Extension messaging (forage production and use, crop residue processing and use and feed rations) using MWANGA.		
Research team:		
Name	*Institution*	*Role*
Ben Lukuyu	ILRI	PI - develop livestock and feed messages, assess effectiveness of these messaging
Leonard Marwa	TALIRI – West Kilimanjaro	Technical backstopping on preparing and delivering livestock messages
Mr. Mbesere	Extension staff – Babati district	Cross-check and translate messages
	ESOKO	Messaging
	IITA	Develop food safety messages
	Development partners (COSITA, World Vision)	Intelligence of farmer messaging monitor farmer feedback
	ILRI	Develops Integrated soil/fertilizer messages
Students: Nil		
Locations:	All villages	
Start date	2018	
End date	2020	
Justification: Farmer/Extension messaging (forage production and use, crop residue processing and use and feed rations) using MWANGA This activity will involve developing short, clear and target messages for dissemination to farmers via SMS aimed at increasing dairy and poultry productivity. This activity is a collaboration between several Africa RISING teams and is led by IFPRI. Other institutions include IITA, CIAT-Kenya and CIAT Rwanda. ILRI will develop and contribute livestock messages that will be disseminated through the Mwanga platform		
Research question: How much can SMS messaging technology reduce key knowledge gaps amongst smallholder farmers?		
Experiment design, implementation and data analysis: There will be a common MWANGA protocol produced by IPFRI that partners will refer to.		

Deliverables:	*Means of verification*	*Delivery date*
Baseline survey of current Knowledge, Practices and Attitudes amongst farmers before intervention	Project report to IITA	March 2019
At least 10 messages to farmers and extension staff about improved technologies disseminated through SMS	Project report to IITA with message content and dates	July 2019
End line survey to measure change in Knowledge, Practices and Attitudes from target farmers	Quarterly Project reports	August 2019
Complete data analysis	Project report to IITA	August 2019
Report to IITA about sub-activity completion	Report	September 2019

How will scaling be achieved?

Partnership with COSITA and World Vision to deliver technology to about 200 farmers through the platform

Sub-activity 1.3.1.2

Produce regionally relevant extrapolation domain maps for validated technologies (vegetable varieties, forage cultivars, maize and fertilizers and conservation agriculture practices).

Research team:

Name	*Institution*	*Role*
Francis Muthoni	IITA	PI
All other sub-activity PIs	Various	Provide technologies and their validation data

Students: Nil

Locations:	Mainly desktop study
Start date	January 2019
End date	2021

Justification:

Sustainable intensification technologies are suited to specific biophysical and socio-economic context. Technologies validated at particular location should be suitable for scaling to other locations with relatively similar biophysical and socio-economic context. Identification of areas with relatively similar conditions or outcomes to that observed in technology trial sites is one of essential component of successful scaling out. Biophysical conditions or yields obtained from trial sites with good performance of particular technological packages will be used as reference for mapping other potentially suitable sites in ESA region. The generated recommendation domain or suitability maps is a step towards establishing regional relevance of Africa RISING validated technologies. The generated suitability maps will guide development partners and extension agencies to scale-out technologies to relevant context thus reducing the risk of failure.

Objectives:

Identify where in the ESA region the validated technological packages can be extrapolated with lowest potential risk of failure. An expanded description of the research questions is given in the Research Protocols 2018-2019 – Appendix 1.

Experiment design, implementation and data analysis: Biophysical and socio-economic data that affect performance of crops will be sourced from the researchers and, together with GIS-sourced data, will be used to to generate clusters for entire ESA regions and update ESA agro-ecological zones map and technology suitability maps. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.		
Data (with metrics) to be collected and uploaded on Dataverse: Not Applicable		
Deliverables:	*Means of verification*	*Delivery date*
Produce agro-ecological zones maps and extrapolation suitability maps for the different technologies.	Maps uploaded on dataverse, and draft manuscript	September 2019
How will scaling be achieved? Train development partners on the use of interactive web-based tool for spatial targeting of technologies and potential impacts.		
How are the activities in this protocol linked to those of others? Technology data for use in extrapolation will be obtained Africa RISING trials.		

Outcome 2: Natural resource integrity and resilience to climate change enhanced for the target communities and agro-ecologies

Output: 2.1:
Demand-driven research products for enhancing soil, land and water resources management to reduce household/community vulnerability and land degradation piloted in priority agro-ecologies [and scaled in Outcome 5]

Activity: 2.1.1: Characterize current policy practices in ESA through identifying formal and informal arrangements for access to and use of water and land resources
No sub-activity proposed for this year. A previous related study was conducted in Kongwa by TARI
Activity 2.1.2: Identify opportunities for using supplementary irrigation in different farming systems of the ESA target country agro-ecologies
No sub-activity proposed for this year. A previous related study was conducted in Babati by CIAT and WorldVeg on vegetable irrigation

Output 2.2:
Innovative options for soil, land and water management in selected farming systems demonstrated at strategically located learning sites [and scaled in Outcome 5]

Activity 2.2.1: Set up demonstration and learning sites in target ESA communities		
Sub-Activity 2.2.1.1: Continuation of CA systems long-term trial at Msekera Research Station in Eastern Zambia		
This sub-activity is formatted differently, and is best described in Research Protocols 2018-2019 - Appendix 2		
Sub-activity 2.2.1.2: Investigations on nutrient and water management for climate resilience along a climate gradient in southern Malawi		
Research team:		
Name	Institution	Role
Regis Chikowo; Sieg Snapp	MSU	PIs, research conceptualization, design, implementation
Julius Manda	IITA	Backstopping on economic evaluation

Gundula Fischer	IITA	Technical backstopping on gender and labor analyses
Anicet Sambala	IITA	M&E
Lieven Claessens	IITA	Ex-ante impact assessment with Tradeoff Analysis Model for Multi-Dimensional Impact Assessment (TOA-MD) for regional relevance of Africa RISING technologies

Students: Nil

Locations:	Linthipe, Golomoti, Kandeu, Nsipe, Mtubwi, Nsanama, Nyambi, Ntiya Extension Planning Areas (EPAs)
Start date	Some sites started 2013; some November 2016
End date	November 2019 (Machinga/Mangochi); September 2021 (Dedza/Ntcheu)

Justification:

In much of Africa, seasonal rainfall predictions are often generalized, limiting their usefulness in practically guiding responsive management on the farms, including choice of appropriate cropping regimes that best-fit expected rainfall quality. Therefore, farmers are exposed to climatic risk in environments with high inter- and intra-season rainfall variability, making fertilizer investments unattractive. Simple approaches to buffer farmers against soil moisture stresses are required. These include in-situ storage of rainwater that comes as high intensity storms associated with large run-off. Simple physical structures such as tied-ridges increase residence time for rainwater to infiltrate.

Objective:

To investigate the interactions between rainfall received, nutrient management and soil type, we will set up two on-farm experiments for each of three agroecologies (sites) in Machinga district, Southern Malawi.

Research question

Does in-situ water harvesting through tied ridges result in better nutrient use efficiencies across sites? What are the unique niches for this practice?

Experiment design, implementation and data analysis:

This study seeks to understand water availability as an indicator of the environmental conditions that limit the efficient use of nutrients, leading to poor productivity. In this workplan, we seek to quantify the benefits of integrated nutrient and water management through simple in-situ tied ridges water harvesting techniques that increase the residence time for rainwater to infiltrate and reduce runoff and erosion. The main plot factor will be water management (tied or no-tied ridges) while sub-plots factors are NP management and cropping sequencing: 1) continuous non-fertilized maize, 2) maize fertilized at 35 or 70 kg N ha^{-1} [N-35 or N-70], 3) sole groundnut or a groundnut/pigeonpea intercrop, both sequenced with maize in Years 2 and 3. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on dataverse

SI Domain	**Responsible institution**
Productivity: Maize, soyabean, groundnut, pigeonpea grain productivity (kg/ha/season);	MSU

maize, soyabean, groundnut, pigeonpea biomass productivity (kg/ha/season); Variability of production (CV); yield gap per crop (kg/ha/season); nitrogen use efficiency (kg grain/kg N applied)	
Environmental: Water availability (soil moisture by treatment); total soil carbon (%SOC); biological N2-fixation estimates (kg/ha N fixed per season); Rating of erosion	MSU
Economic: Profitability of different technologies; Net income ($/crop/ha/season); Gross margin ($/ha/season); Benefit-Cost Ratio; Input use intensity (input kg/ ha); Labor requirement - farmer rating of labor	MSU and IITA
Social: Rating of technologies by gender	MSU and IITA
Human Condition*:* Nutrition- protein production (g/ha); Food security - food production (calories/ha/year)	MSU

Deliverables:	*Means of verification*	*Delivery date*
• SI Field trials established for each site	List of field trials, host farmer names available	January 2019
• Benefits of SI technologies evaluated across sites	Productivity data files available	September 2019
• At least one field day per site conducted	Field day reports	September 2019
• At least 3 farmer exchange visits conducted	Farmer exchange visits reports	August 2019

How will scaling be achieved?
Malawi extension system (District Agricultural Extension Coordinating Committees – DAECC) that has oversite on technology dissemination at district level will help disseminate technologies in Extension Planning Areas (EPAs) that are not physically reached by Africa RISING project. The DAECC constitutes a network that includes district-level government extension system and all NGOs operating in the district. This body harmonizes agricultural technologies dissemination approaches and improves the efficiency of use/allocation of financial resources by different actors in the different EPAs.

How are the activities in this protocol linked to those of others?
Choice of crop varieties has been harmonized based on experiences and technical advice from ICRISAT. For example, groundnut varieties used in this sub-activity and in LUANAR sub-activity B are based on guidance from ICRISAT breeders. Increased productivity of grain legumes based on this sub-activity is directly linked to nutrition studies.

Sub-activity 2.2.1.3
Test climate-smart farming practices (tied ridges, weather-informed varieties, cover crops integration [cowpea, lablab, medium duration pigeon pea]) for increasing productivity of maize-legume system under variable weather conditions

Research team:

Name	*Institution*	*Role*

Job Kihara	CIAT	PI
Jonas Rose	MoA	Supervise field operations by farmers
Anicet Sambala	IITA	M&E Support
Students: Nil		
Locations:	Sabilo and Gallapo	
Start date	Dec 2016	
End date	Nov 2020	

Justification:
Farmers continue to face challenges related to weather variability in crop production. In Babati, the 2015-16 cropping season for example resulted in large losses in productivity. Also, farmers expressed the need for climate smart technologies during a stakeholder needs assessment prior to Phase-2 of Africa RISING (progress reports by Kihara). Various opportunities exist to address the rainfall variability challenge. One option is to utilize weather forecasts information in making decisions on planting dates. While such information is being relayed and now at the click of phone gadgets, it is not clear how such information will improve production relative to conventional farmer planting timing. Other opportunities of addressing challenges of rainfall variability include integration of in-situ water harvesting, cover crops and improved fertilizer management. This research addresses response of crops to the combined application of these technologies. . An expanded description of the justification is given in the Research Protocols 2018-2019 – Appendix 1.

Objectives:
1. Assessing the effects of different climate-smart farming practices on productivity of maize and pigeon pea
2. To determine gender-related social constructs related to implementation of selected climate-smart farming practices (for 2019/2020 season)

Research questions:
1. To what extent do tied ridges affect productivity in different ecozones and weather variability in Northern Tanzania?
2. To what extent is crop diversification an option for improving resilience under climate variability?
3. What are the gross margins associated with selected climate smart agricultural practices in northern Tanzania?

Experiment design, implementation and data analysis:
The experiment is laid out as a randomized complete block design with 7 treatments (described in the research protocol). In each field, each treatment is replicated 3 times. Treatment plot size are 7m x 5m. The net plot used for measurements of grain and biomass will leave out 1 m from each side of the plot to reduce border effects. In all treatments, two maize seeds will be planted at a spacing of 25 × 75 cm, and later thinned to one, to attain a plant population of 53333 plants per hectare. Pigeon pea and beans are planted to also attain similar densities across plots. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on dataverse

SI Domains	Responsible institution
Productivity: Crop productivity and crop biomass productivity (Yield production, residue production at plot level) 1. Maize grain yield at plot level (kg/ha/season). 2. Maize stover yield at harvest at plot level (kg/ha/season) 3. Pigeon pea grain yield at plot level (kg/ha/year)	CIAT/MoA
Environmental: Soil water conservation and Soil nutrient levels (Soil physical properties (soil moisture) at plot level. Daily rainfall and temperature measurements at community/landscape level. Chlorophyll meter readings at plot level.) 1. Soil moisture at plot level (m^3m^{-3}) 2. Daily rainfall at community/landscape level (mm) 3. Daily temperature measurements at community/landscape level (°C)	CIAT/MoA
Economic*:* Profitability and labor requirements (Profitability (gross margin at plot level and labour requirement) *1.* Profitability- gross margin at plot level ($/crop/ha/season) *2.* Labour requirement (farmer rating of labour)	CIAT
Social*:* Gender equity • Rating of technologies by gender	CIAT/MoA
Human Condition*:* Food security and nutrition (Food production at plot level and using available literature derive protein output) *1.* Food production at plot level (Calories/ha/year) 2. Using available literature derive protein output (g/ha)	CIAT

Deliverables:	*Means of verification*	*Delivery date*
4 on-farm trials, 2 in each of 2 eco-zones, successfully Implemented	Research reports	October 2019
2 new technologies being tested	Research reports	October 2019
30 farmers trained	Training report	August 2019
Soil moisture and SPAD data uploaded	Uploads	October 2019

How will scaling be achieved?
Partnership with Meru Agro Seed Company to deliver Improved maize seeds and provide advice to farmers, with World Vision and with Cosita to potentially utilize Mwanga ICT platform in communication of agronomic information. Besides, farmers already enlisted in Mwanga will receive monthly agronomic messages.

How are the activities in this protocol linked to those of others?
ILRI and TARILI utilize residues from toppings and strippings for livestock. Double-up legumes also contained in protocols for Kongwa-Kiteto and Malawi. We are utilizing Mwanga ICT, a tool developed within Africa RISING.

Sub-activity 2.1.1.4
Land rehabilitation through integration of fodder trees and grass forage species in dryland farming

Research team:

Name	Institution	Role

Anthony Kimaro	ICRAF	PI, Research design and oversight of project activities
Emmanuel Temu	ICRAF	Socio-economic, gender and labor studies
Julius Manda	IITA	Economic analyses support
Gundula Fischer	IITA	Gender and labor analyses support
Francis Muthoni	IITA	GIS Support
Lieven Claessens	IITA	System analysis support
Anicet Sambala		M&E Support

Students: Nil

Location(s):	Mlali village in Kongwa District
Start date	October 2014
End date	September 2020

Justification:

Since 2014 ICRAF has trained 151 farmers (52.5% Female) on tree seedling production and agroforestry technologies for semiarid sites. These farmers have mainly intercropped *G. sepium* with cereals while others planted the tree species on contours to stabilize banks and provide intermediate benefits like fodder and fuelwood supply while enhancing the soil erosion control features. Crops and wood yields from trees planted in various niches on-farm has been assessed and preliminary results presented in a book chapter analyzing the multi-dimensionality of climate smart agriculture in Tanzania. Overall, maize yield in farmer managed demonstrations with *G. sepium* intercropping (baby trials) was 50% higher than 1.5 t ha^{-1} obtained in the farmer practice. Farmers have interacted with the introduced agroforestry technologies (mainly *G. sepium* intercropping and contours) for 2-3 years, which provides a useful sample for socio-economic assessment of the benefits of the technology in addition to biophysical assessment of land rehabilitation effects already noted in some farmers fields like Moshi Maile. Thus, the assessment of gender, labour and other impacts of these technologies will be conducted during this study, using farmer Moshi Maile as a case study. An expanded description of the justification is given in the Research Protocols 2018-2019 – Appendix 1.

Objective:

To evaluate crop yields and land rehabilitation benefits and socio-economic benefits of agroforestry-based contour farming.

Experiment design, implementation and data analysis:

Since 2014, demonstrations on contour farming were established in established in various fields by TARI-Hombolo using the A-frame method as part of landscape-based soil erosion control. ICRAF planted *G. sepium* at 3-m spacing and grass fodder (Guatemala grass) at 1-m intervals in selected farmer fields to re-enforce the contour bunds and provide additional benefits of fodder and fuelwood. There have been variable survival rates of planted vegetation in various farms, but crop performance at Moshi Maile's sites (the upland and the lowland farms) are in good conditions to support the evaluation of sustainability of contour farming using the SI domain framework. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on dataverse	
SI Domain	**Responsible institution**
Productivity*:* Maize grain and stover yield (t/ha); wood and foliage biomass (t/ha)	ICRAF
Environmenta*l:* Soil fertility (g/kg-soil); Soil moisture (%), Rainwater use efficiency (kg/mm/yr); Nutrient uptake (kg/ha); Nutrient use efficiency (kg/uptake)	ICRAFR SUA and IITA
Economic*:* Gross margin in USD/ha and Benefit-Cost Ratio-BCR;	ICRAF and IITA
Social*:* Food availability (number of food sufficiency month per household/year)	ICRAF and IITA
Human Condition: Perception of benefits of the technology by gender	ICRAF and IITA

Deliverables:	*Means of verification*	*Delivery date*
Co-organized farmer field day and Nane-nane exhibition	Activity/progress report	May and August, 2019
Farmer-to-farmer exchange on agroforestry educ. Facilitated	Activity/progress report	June, 2019
Effect of various contour components on productivity (biomass and grain yields) determined	Activity/progress report	August 2019
Soil restoration benefits (soil fertility and erosion) of contour farming assessed	Activity/progress report	August 2019
Economic benefits of two model contour farms integrating *G. sepium* and grass fodder evaluated	Activity/progress report	September 2019
Gender analysis of at least 10 farmers with contours completed	Activity/progress report	September 2019

How will scaling be achieved?

ICRAF will work with the Dorcas group at Mlali, TANAPA (Kilosa), VAEOs and DAICOs in Kongwa to deliver at least 10,000 seedlings and agroforestry education to non-AR sites (e.g., Ngumbi, and Kitete Msindazi villages)

How are the activities in this protocol linked to those of others?

Test crop (Maize variety and pigeonpea) to be used in this trial are promising variety selected by ICRISAT and CIMMYT. *G. sepium* fodder is used in pen goat feeding trials in Malawi and similar work can be adopted for Kongwa for draught animals, which needs supplementary feeding for high productivity. Also used in poultry feeds in the KK/Babati poultry feed experiments

Sub-activity 2.2.1.5

Evaluation of land rehabilitation benefits of shelterbelts and contours

Research team:

Name	Institution	Role
Mawazo Shitindi	SUA	Lead researcher coordinating sampling processes and overseeing laboratory analysis and research report production

Anthony Kimaro	ICRAF	Provide baseline information on the design of shelterbelt and contour research plots, data of soil properties and general classification of soils in the study area.
Elirehema Swai	TARI Hombolo	Provide baseline design of soil water conservation research plots and data of soil properties in the study area before initiation of contour bunds
Anicet Sambala	IITA	M&E Support
Students: Nil		
Location(s):	Mlali Molet and Laikala villages of Kongwa district	
Start date	October 2017 (New sub activity building on what has been done by TARI Hombolo and ICRAF since 2014)	
End date	September 2020 for a full project cycle	

Justification:

Being part of soil and water management effort, a shelterbelt demonstration site was established in 2014 with three strips of tree rows each 100 m long covering the entire field. Similarly, contour farming demonstrations were established in various fields and stabilized with agroforestry trees (*G. sepium* and a row of *G. robusta)*. In the first three years of demonstration plot establishments, root collar diameter, diameter at breast height (dbh), plant height, and tree survival was measured for estimation of wood and foliage (fodder) biomass yields. In 2018 season data on alley cropped maize, fodder and wood yield were also collected and will continue in 2019 and 2020 to account for seasonal variation and generate data for other SI domains needed to evaluate the sustainability of the shelterbelt technology. Apart from the estimation of wood, foliage (fodder) biomass and alley cropped maize, land rehabilitation benefits of the shelterbelts have not been established, and form the basis for this study. An expanded description of the justification is given in the Research Protocols 2018-2019 – Appendix 1.

Objective:

To evaluate land rehabilitation benefits (soil erosion control and soil fertility restoration) of shelterbelt and contour farming

Experiment design, implementation and data analysis:

Evaluation of land rehabilitation benefits of shelterbelts and stabilized contours will involve analysis of key physical, chemical and biological properties of soil influencing its fertility status. Physical properties to be studied will include soil depth, bulk density, soil texture, and soil moisture characteristics (hydraulic conductivity). Soil chemical properties to be studied will include soil pH, organic carbon (OC), total N, NH_4^+ -N, extractable P, SO_4 – S, Exchangeable cations (Ca, Mg, K and Na), cation exchange capacity (CEC), and DTPA extractable micronutrients (Zn, Fe, Cu and Mn). Biological properties such as microbial populations and activities, microbial biomass and activities of soil enzymes are equally important to assess changes in soil quality as influenced by shelterbelt technology. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on dataverse

SI Domains		Responsible institution
Productivity: Crop yields (t/ha) of grain and stover of wood		SUA
Environmental: Nutrient availability (mg/kg soil); Soil carbon (g/kg soil); Nutrient input through litter fall; soil loss kg/ha/year); nutrient uptake and nutrient exported out of the fields (kg/ha) and reduced soil loss (kg/ha)		SUA
Economic: Profitability of technology (gross margin in USD/ha); Cost-Benefit ratio (USD/USD).		IITA
Social*:* Farmers perceptions of the environmental and economic benefits of the shelter belt and contours (Numbers by gender and age groups); returns on labor investment (USD/person day)		IITA
Deliverables:	*Means of verification*	*Delivery date*
Research protocol developed	Approved research protocol	December 2018
Soil and plant sampling conducted for laboratory analysis	Soil and plant samples registered in the laboratory	January 2019
Laboratory analyses conducted and data sets for the first year (2018/2019) uploaded on Dataverse	Data sets uploaded and report on land rehabilitation benefits of shelterbelts and contours	31 August 2019
Assessed soil erosion control benefits of contours and shelterbelts and linked to land rehabilitation processes and social - economic benefits of the technologies	Annual report	September 2019

How will scaling be achieved?
Development partner interested in this activity will also be thought to help in taking it to scale and partnership with DAICOs to disseminate the technology using demonstration plots and extension materials.

Linkage of the activities in this protocol to those of others:
Agronomic practices (ICRAF); Shelter belts and contours evaluated for land rehabilitation benefits are currently part of studies on Integrating fodder tree and grass forage species in dryland farming (ICRAF) and S&WC (TARI Hombolo)

Sub-activity 2.2.1.6
Validation of residual tied ridging as a labor-saving technology in semi-arid Areas of Central Tanzania

Research team:

Name	*Institution*	*Role*

Elirehema Swai	TARI Hombolo	PI - responsible for research design and oversight of the project activities
Edward Lutengano	University of Dodoma	Economic data collection
Julius Manda	IITA	Backstopping UDOM economist on economic data collection
Gundula Fischer	IITA	Gender analysis and technical backstopping to social scientists from the University of Dodoma who will be engaged for data collection and evaluation
Mawazo Shitindi	Sokoine University of Agriculture	Soil fertility studies
Christoper Mutungi	IITA	Nutrition analysis of maize grain samples from different technologies
Anicet Sambala	IITA	M&E Support
Location(s):	Laikala, Mlali, Ngumbi and Sagara villages in Kongwa District	
Start date	2016/2017	
End date	September 2021	

Justification:

Introduction and popularization of technologies aiming at reducing drudgery for rural overburdened resource constrained farming communities is immensely important. Thus, a study on the use of Residual Tied Ridging (RTR) tillage technique as labour saving technology will be assessed during the 2018/2019 cropping season as a sound strategy for alleviating labor bottleneck. The principal potential benefit behind of using RTR technique is that in the first cropping season the land is ploughed, ridges and cross ties are made, and high labor input would be required. In the subsequent cropping seasons, tied ridges made in the previous season will be maintained (hence residual) and just re-shaped to their original size, ready for planting. Despite accrued benefits associated with RTR technology such as increased crop yields, the information on labour reduction, soil water infiltration and degree of soil compaction are lacking for informed decision making and will be generated during this study. An expanded description of the justification is given in the Research Protocols 2018-2019 – Appendix 1.

Research question:

What biophysical and socio-economic factors distinguish the benefits between residual tied ridges, annually made tied ridges and conventional farmer practice?

Experiment design, implementation and data analysis:

The study will be undertaken in each participating village having tied ridges constructed on 2016/2017 cropping season. A Split-plot Design with two factors namely tillage methods (i.e. Annual tied ridging (ATR), Residual tied ridging (RTR) and Conventional farmer practice, (CFP) and two improved maize varieties (1 commercial maize variety commonly grown by participating farmers) and one promising drought tolerant maize (DT) variety as recommended by CIMMYT. This will consist of six treatments that will be replicated three times at each site. All treatments will be applied with 20kg P/ha of Diammonium Phosphate (DAP) fertilizer at planting and Urea (40 kg N/ha) will be applied as a topdressing. Biophysical and socio-economic data will be collected and analyzed. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on Dataverse:	
SI Domain	**Responsible institution**
Productivity Crop Productivity: Maize grain yield (kg/ha/season) Crop biomass productivity: Maize stover yield (kg/ha/season)	TARI Hombolo
Environment Soil physical quality: Soil bulk density (g/cm3) Water availability: Cumulative infiltration (mm); soil moisture content (%); rainwater use efficiency (kg/mm/yr); water productivity	TARI Hombolo
Economic Profitability: Gross margin (USD/ha)	University of Dodoma/IITA
Social Gender equity: Farmers perception on labor requirement on the use of residual tied ridging technology segregated by gender	IITA
Human Condition Nutrition : Protein production (g/ha); micronutrient production (g/ha) Food security: Food production (calories/ha/yr)	IITA

Deliverables:	*Means of verification*	*Delivery date*
At least thirty (30) experimental plots both mother and baby trials on the use of residual tied ridging tillage technology initiated in Kongwa District during 2018/2019 cropping season.	Quarterly report	By February 2019
Accrued social and economic benefits of using residual tied ridging technology segregated by gender quantified.	Progress Report	Sept 2019
Information on productivity, environment, and social benefits associated with the use of residual tied ridging technology in Kongwa District in areas of Dodoma Region quantified.	Progress Report	Sept 2019
Information on the effect of residual tied tillage technique on protein content, micronutrient content, and food safety available.	Progress Report	Sept 2019
Farmers Field days (FFDs) conducted in at least two participating villages.	Field day report	April to May 2019

How will scaling be achieved? Through the involvement of ward/village extension officers and councillors in Kiteto and Kongwa District Councils. Similarly, farmers' field days will be conducted to showcase best practices and thus will engage farming communities in the project area as well as neighboring villages**.**
How are the activities in this protocol linked to those of others? The *in-situ* rainwater harvesting technology is being validated with improved drought-tolerant maize variety (CIMMYT) as well as soil fertility management (SUA/ICRAF).

Sub-activity 2.2.1.7 Demonstrate technologies on soil and water conservation for enhancing resilient to climate change in semi-arid agro-ecologies of Central Tanzania		
Research team:		
Name	*Institution*	*Role*
Elirehema Swai	TARI Hombolo	Responsible for research design and oversight of the project activities
Gundula Fischer	IITA	Gender analysis and farmers perceptions
Anicet Sambala	IITA	M&E Support
Locations	Laikala, Mlali, Nghumbi and Laikala villages in Kongwa District	
Start date	2014/2017	
End date	Sept 2021	
Justification: Over the last four cropping seasons (i.e. 2013/2014 to 2016/2017), the Africa RISING Project introduced and popularized a Fanya juu terrace technology in erosion-prone areas of semi-arid Kiteto and Kongwa districts as a sound strategy for addressing the challenges of soil erosion. Despite these achievements, information on gender and farmers' perceptions on the use of the terrace technology for addressing soil erosion intricacy in the case study sites is lacking. Thus, based on the Sustainable Intensification Assessment Framework (SIAF) the study will be undertaken in Kiteto and Kongwa districts to generate information on how socio-economic factors (contextual factors) influence the adoption of Fanya juu soil erosion control technology in the farming systems of semi-arid areas of central Tanzania. An expanded description of the justification is given in the Research Protocols 2018-2019 – Appendix 1.		
Research questions: i. How does collective action influence the adoption of Fanya juu terrace technology among smallholder farmers in Semi-arid ecologies of Central Tanzania? ii. How do socio-economic factors influence the engagement of farming communities in collective actions and adoption of Fanya juu terrace technology? iii. What are male and female farmers' perceptions on "Fanya juu terrace" technology?		
Experiment design, implementation and data analysis: The study will engage farmers who have installed Fanya juu terrace in their fields in Kongwa during 2013 and 2017 cropping seasons. The list of all farmers installed Fanya juu terraces overtime across action sites will be generated. The same farmers, later on, will be engaged in the studies (focused group discussions (FGD) and interviews to generate more information on the importance of community cohesion and socio-capital in the adoption of the soil and water conservation practices. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.		
Data (with metrics) to be collected and uploaded on Dataverse:		
SI Domains		**Responsible institution**

Economic Profitability: Gross margin (USD/ha)		University of Dodoma/IITA
Social Gender equity: Farmers perception of technologies/information segregated by gender		IITA
Deliverables:	*Means of verification*	*Delivery date*
Socio-economic study on the use of terrace technology segregated by gender conducted	Progress Report	Sept 2019
How will scaling be achieved? Sharing of research findings with key stakeholders in Kiteto and Kongwa districts for informed decision making.		
How are the activities in this protocol linked to those of others? It is built upon the ongoing soil and water management initiatives in Kiteto and Kongwa districts.		

Outcome 3: Food and feed safety, nutritional quality, and income security of target smallholder families improved equitably (within households)

Output 3.1: Demand-driven research products to reduce postharvest losses and improve food quality and safety piloted in target areas [and scaled in Outcome 5]

Activity 3.1.1: Conduct packaging and delivery of postharvest technologies through community and development partnerships with iterative review, refining, and follow-up		
Sub-activity 3.1.1.1 Assess the impact of nutritional messaging on farmers nutritional knowledge, attitude and practices and household nutrition status, in partnership with Islands of Peace		
Research team:		
Name	*Institution*	*Role*
Justus Ochieng	WorldVeg	PI
Ludovic Joly	Iles de Paix (IDP)	Fund and participate in nutrition training.
CHistopher Mutungi	IITA	Contribute to training post-harvest handling of foods for improved nutritional outcomes and participate in baseline data collection.
Anicet Sambala	IITA	M&E Support
Students: Nil		
Locations:	16 Villages in Karatu: 8 are listed while additional 8 villages will be identified by IDP. Kambi ya samba, Bashay, Buger, Gyekrumlambo, Slahhamo, Rhotia Kainam, Chem Chem, Changarawe.	
Start date	2017	
End date	2019	
Justification: Smallholder farmers are also consumers of harvest they produce. Hence, improved knowledge about the post-harvest quality and nutritional significance of a high diversity of foods could therefore have an immediate impact on their livelihoods. In this context, Ochieng et al. (2016) found that households benefiting from traditional African vegetables (TAV) promotion and demand creation activities had a significantly higher dietary diversity for children under five and women of reproductive age. The integration of dietary diversification with better postharvest management of common staples has the potential for stepping–up the improvements of household nutritional outcomes. Therefore, this intervention will not only introduce different vegetable-based recipes but also encourage the households to eat nutritious and diverse diet for healthy living while also ensuring better postharvest management of harvested produce. It also aims at influencing key vegetable value chain actors such as government through the Ministry of Agriculture (MoA), and Ministry of Health and Social Welfare (MOH&SW), and NGOs (RECODA, IDP, MVIWATA) towards implementing interventions that lead to		

positive nutrition outcomes; growing diverse and nutrient rich crops, off-season vegetable production, and implementing postharvest handling practices. The objective is to increase consumption of diverse nutrient-rich foods by poor rural and peri-urban households in Tanzania.
Objectives: 1. To increase consumption of diverse nutrient-rich foods by poor rural and peri-urban households in Tanzania. 2. To assess the impact of nutritional messaging on farmers nutritional knowledge, attitude and practices and household nutrition of rural households.
Experiment design, implementation and data analysis: The nutritional messages developed by Worldveg's Nutrition-Sensitive Promotion of Vegetables (NutriSenseProm) project in Kakamega Kenya will be adapted to local situation before training the households and food kiosks in Karatu. The intervention will be done in 16 villages and 8 of these villages will participate in experiment 1 above while IDP will scale out the technologies in 8 additional villages. For the intervention areas/villages the project will employ three randomly assigned treatments: (1) Without any nutritional message (control)-10 groups, (2) Nutrition message 1 (M1)-8 groups and (3) Nutrition message (M2)-8 groups. Intervention groups will be provided with seed kits to facilitate production vegetables and trained together with WorldVeg, IITA and IDP. For ethical reasons the control group will be provided with seed kits so that the participants receive some input and consequently receive a kind of treatment. Two sets of messages will be tested. The food kiosks (*Mgahawa in Kiswahili*) will be trained on preparing vegetable-based recipes and their acceptability evaluated. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on Dataverse	
SI Domain	**Responsible institution**
Productivity: Crop productivity: Vegetable yield (kg/ha/season)	WorldVeg
Economic: Income diversification: Income diversification index (Simpson index and number of income sources) Market participation: Market orientation index (% of vegetables sold to the market Data to be collected: Sources of income, price of each marketable crop, quantity of vegetables sold	WorldVeg
Human condition: Nutrition: Access to diverse foods -vegetables (#), Dietary diversity (score-0-12) Capacity: % of farmers applying or experimenting improved nutritional practices Data to be collected: Vegetables produced, Food types consumed by the household in 24 hours, Number of farmers applying improved practices	WorldVeg
Social: Nutrition outcomes by gender Data to be collected: Disaggregated nutrition outcomes by women and men	WorldVeg

Deliverables:	*Means of verification*	*Delivery date*
Baseline survey	Baseline data in Dataverse	March 2019
Number of households trained on nutrition including recipes. One sensitization meeting per group At least 450 farmers trained At least two new vegetable-based recipes developed and promoted (excluding those developed by WorldVeg in the past). At least four food kioks/restaurants incorporated in their food menu.	Training report, Sensitization meeting reports, Reports on recipes	September 2019
At least 1 success/blog story	Success story online	September, 2019

How will scaling be achieved?
IDP will conduct nutrition messaging in other areas in Karatu. RECODA and MVIWATA are interested to incorporate nutrition messaging in their programs in Babati.

Sub-activity 3.1.1.2:
Evaluate influence of farmer storage structures and environment on physical and economic losses abatement by hermetic storage devices

Systems Research team

Name	*Institution*	*Role*
Christopher Mutungi; Adebayo Abass	IITA	IPI. Lead set-up on-farm crop storage trials of maize and cereal legumes (common beans) in Karatu district.
Job Kihara	CIAT	Investigate benefits of maize / legume cropping systems in Babati; IITA's storability data from Karatu will contribute to the productivity and economic indicator domains with postharvest losses data and price advantage data from improved storage.
Elirehema Swai; Bright Jumbo	TARI Hombolo/ CIMMYT	TARI/SUA/ CIMMYT will be investigating soil management and variety performance trials in Kongwa; IITA storability data will contribute to their productivity and economic indicator domains.
Anicet Sambala		M&E support
Fred Kizito	CIAT/IITA	Will set up and manage ICT communication platform

Students

Name	*Institute*	*Degree*	*Start*	*End*
Expected but not confirmed	Sokoine University	Masters; Socioeconomics	June 2019	

Location(s)	KARATU District (Villages: Changarawe, Bashay, Slahammo, Buger, Chemchem, Kambi ya simba, G. Lambo, K. Rhotia);
Start	2018
End	2020

Justification:
Successful on-farm storage of harvested produce depends on the interaction of many factors; key among them is the storage environment which comprises typical storage structures of smallholder farmers. These vary from farmer to farmer because of differences in resource endowment, farmers' knowledge, socio-cultural factors etc. During Africa RISING reconnaissance visit in Karartu district, some farmers reported having used hermetic bags successfully, but others also reported challenges - damage by rodents and insects that made the technology ineffective, or had no knowledge of the technology So, in addition, environmental factors influence the prevalence and spread of biotic factors (insect pests, rodents, molds) that are responsible for loss or spoilage of the stored produce. Thus there may be context-specific challenges in the performance of hermetic storage devices. It is therefore important to understand how air-tight storage technologies might perform where conditions are diverse in terms of the storage structures and store management practices, and how farmers (traders and consumers) value improvements or loss of produce quality during storage. A broader context description is given in the Research Protocols 2018-2019 – Appendix 1.

Research questions:
What are the associated constraints to and opportunities for the adoption of SI technologies at farm typology and intra-household levels? Specifically:

1. How does on-farm storage environment (e.g. storage structures) influence performance of different types of air-tight storage devices?
2. Is there a perceived price advantage for produce (maize/ beans) that has been stored in air-tight storage bags?

Experiment design, implementation and data analysis:

- An initial survey will be conducted to characterize the sampled farm households.
- The research team will meet with members of the group to help identify two (2) farmers to engage in the project. The inclusion criterial of the farmers will include: willingness to participate during the entire study period; own sufficient grain to donate for the experiment; and trust by the group members. Verbal consent of the selected farmers will be sought.
- A randomized block design with factorial treatment structure will be used in setting up the participatory on-farm trials. Each farm will be considered a block given the uniqueness of the storage environment/practices/ conditions.
- Farmers will be asked to show the researchers the newly harvested threshed produce (maize or beans, or both) which they wish to donate for the experiment. The produce in bags will be randomly allocated to each of the three storage technologies (double layer hermetic bag; single layer hermetic bags; Woven polypropylene bag).
- The variety of maize or beans stored will be carefully marked of the device. The farms will be followed up for a period of 7 months with sampling at baseline, 3.5 months and 7 months.
- Data loggers will be installed to record temperature and relative humidity data.

An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on dataverse		
SI Domains		**Responsible institution**
Productivity: Avoided postharvest loss (kg/ha).		IITA
Environmental NA		
Economic: Profitability; Price advantage for improved quality grain; $/kg at farm level.		IITA
Social: Gender equity; Rating of air-tight storage technologies by gender		IITA
Human Condition: Food security: additional food availability/ additional months of food security Capacity to experiment: number of new management practices being tested by households		IITA
Deliverables	*Means of verification*	*Delivery date*
1. Performance of hermetic storage devices under diverse farmer storage conditions and environments known.	Report, draft publication	June 2019
2. Potential price advantage for improved produce quality as a result of storage in hermetic bags determined.	Report; draft manuscript for publication; data uploaded on dataverse	September 2019
3. 360 farmers trained, and capacity of 10 government extension officers / 5 development partner staff enhanced through village-based field days.	Training report; FTF data	September 2019
4. At least 10 messages (1 monthly) on improved postharvest management shared with farmers and extension staff.	Workshop report on IT delivery of targeted messages to support farmer adoption of improved SI technologies	September 2019

How will scaling be achieved?

On-farm storage demos will be installed in collaboration with Iles de Paix in at least 30 households. These households are selected through a participatory process to represent 360 farmers already mobilized into 16 groups of 20-30 learners across 8 villages. The demos will as well be sampling points. Each of the 360 farmers is expected to spread to at least 3 other farmers making about 1440 learners in 2018/19. Farmer learning will be supported by ICT messaging on MWANGA Platform.

How are the activities in this protocol linked to those of others?

CIAT is conducting production activities on maize and legume cropping systems in Babati. TARI Hombolo/ CIMMYT/SUA are undertaking soil improvement and variety testing trials in Kongwa. The data of these partners will be complemented with grain storability data, in the productivity, nutrition, and economic indicator domains. ICT messaging in terms of knowledge, altitude and behavior change will be assessed in subsequent years of the partnership.

Sub-activity 3.1.1.3 Evaluate the nutritional, safety and utilization quality of harvested produce, and the stored or processed products				
Systems research team				
Name	Institution	Role		
Christopher Mutungi; Adebayo Abass	IITA	PI. Evaluate nutrient contents, and the processing and utilization quality of harvested and stored maize and legume varieties.		
Elirehema Swai; Mawazo Shitindi	TARI Hombolo/ SUA	TARI and SUA will investigate benefits of integrated soil management practices in Kongwa; IITA's nutritional quality data will contribute to the human indicator domains.		
Anicet Sambala	IITA	M&E Support		
Job Kihara	CIAT	CIAT will investigate maize / legume cropping experiments; IITA's nutritional, safety and utilization data will contribute to their human condition indicator domain.		
Students				
Name	*Institute*	*Degree*	*Start*	*End*
Expected but not confirmed)	University of Dar es Salaam	Food Science and Technology	June 2019	Dec. 2020
Locations	KARATU District (Villages: Changarawe, Bashay, Slahammo, Buger, Chemchem, Kambi ya simba, G. Lambo, K. Rhotia); Kongwa			
Start	2018			
End	2020			
Justification: Understanding how processing and food storage practices affect the nutritional quality of food utilized by households is beneficial for intensification especially where diets are generally less diverse. Processing methods and storage conditions cause changes in nutritional quality and the utilization characteristics of food. The changes may be related to factors such as variety, harvesting stage, and growing conditions in the field, among others. Airtight storage prevents food loss by stopping damage by insect pests. Less reported are the impacts on and the utilization characteristics of the stored produce. Legumes in particular, develop hard-to-cook defect when stored in warm humid conditions. The defect is associated to loss of preferred consumer-characteristics. Understanding this trade-off is important in defining the benefits of the technology within the frame of sustainable intensification. A broader context description is given in the Research Protocols 2018-2019 – Appendix 1.				

Objectives: To evaluate the effects of postharvest processing and storage on the nutritional value of harvested crops and contribute to better food utilization by households.		
Research questions: 1. What are there variations in nutritional composition of harvested maize and common bean varieties? 2. To what extent do air-tight storage devices preserve the nutritional and consumer- preferred characteristics of stored produce? 3. Are there differences in the processing characteristics of harvested maize and legume varieties?		
Experiment design, implementation and data analysis: • The experimental factors are: Variety (two commonly cultivated bean varieties, while for maize the varieties are diverse) X Storage device (air-tight or not air-tight) • Freshly harvested maize and common bean produce provided by farmers for the storage trial will be identified by variety. • The produce will be sub-sampled and taken to the laboratory for baseline analysis. The samples will be analyzed for physical and processing characteristics (hulling and milling), and compositional properties (protein and micronutrients) and cooking characteristics (pasting and textural properties). • Subsequent samples will be drawn from storage devices at 3.5 months and 7 months. These will be re-analyzed to track the changes the compositional and cooking characteristics. • An evaluation of farmer perceptions and preferences (by gender) for the different varieties will be carried out at the tail-end of the trial. • Results will be matched to the storage conditions as described in sub-activity 3.1.1.2. • Data collection description and analysis are given in the Research Protocols 2018-2019 – Appendix 1.		
Data (with metrics) to be collected and uploaded on dataverse		
SI Domains		**Responsible institution**
Productivity: NA		IITA
Environmental: NA		
Economic: NA		IITA
Social: Gender equity; Rating of stored produce quality by gender		IITA
Human Condition: *Nutrition*: protein and micronutrient production (g/ha) at farm level; *Food security (utilization)*: protein and micronutrient composition (g/kg) at household level		IITA
Deliverables	*Means of verification*	*Delivery date*
Nutritional, processing and cooking properties of maize and common beans stored in air-tight and devices determined, and the advantage quantified.	Report; draft manuscript for publication; data uploaded on dataverse	September 2019

How will scaling be achieved? IITA will work in collaboration with Iles de Paix install household storage demos in Karatu district, targeting 360 farmers to begin with, as expounded in activity 3.1.1.2 above. The household storage demos will be learning centers for improved post-harvest management of harvested produce.
How are the activities in this protocol linked to those of others? TARI Hombolo/SUA are investigating integrated soil management and crop production in Kongwa. This partner could provide samples of harvested produce for nutritional and aflatoxin analysis, in order to elucidate contribution of soil management (tied ridges and fertilizer micro dosing) practices on quality of grain crops. CIAT is integrating maize and legume production systems in Babati. These system partners will be availed with data to model yields into actual nutrient production in order to answer the question of how soil management and cultural practices influence nutritional quality of crops for humans (and livestock) in an integrated system; and how postharvest operations influence the nutritional value.

Output 3.2: Nutritional quality due to increased accessibility and use of nutrient-dense crops by farmers improved

Activity 3.2.1 Promote and deploy nutrient-rich crop varieties and livestock feed resources in target communities		
Sub-activity 3.2.1.1 **Elucidate pathways to sustainable adoption of nutrient diets and aflatoxin mitigation practices in rural communities of Central Tanzania**		
Research Team		
Name	*Institution*	*Role*
Yacinta Muzanila	SUA	PI. Coordinate assembly of data from both research and monitoring activities
Wanjiku Gichohi	ICRISAT	C0-PI. Coordinate assembly of data from both research and monitoring activities.
Anicet Sambala	IITA	M&E Support
Locations:	Babati, Kongwa and Kiteto Districts	
Start date	September 2017	
End date	15th September 2019	
Justification: Malnourished adolescent girls and women are more likely to give birth to low birth weight infants, who are stunted in childhood and later life, thus conveying under nutrition from one generation to the next. This has grave immediate and future health and economic implications. Action targeting malnutrition in women of reproductive age and infants and young children is thus required. Previous efforts-combined trainings on nutrient dense recipes, food safety and sanitation and hygiene will continue. To strengthen the previous work, barriers to adoption of nutrient dense recipes as well as aflatoxin mitigation practices will be identified. This, combined with information on drivers of food		

choice, will be crucial in designing interventions that result in adoption of promoted practices. An expanded description of the justification is given in the Research Protocols 2018-2019 – Appendix 1.
Objectives: To identify factors that influence the process of food decision-making among rural communities of Kongwa and Kiteto in the context of the nutrition transition from maize based depended diets.
Experiment design, implementation and data analysis: The conduct of focus group discussions followed by attribute-pile sort will lead to construction of a questionnaire that will be used as a tool to generate information along the 12 constructs of the food-choice model; knowledge, perceived susceptibility, perceived severity, health value, healthy behaviour identity, attitudes towards behaviour, perceived barriers, subjective norms, control belief, cues to action, behaviour intention, and behaviour. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on Dataverse	
SI Domain	**Responsible institution**
Economic: • Per capita household consumption expenditure	ICRISAT
Social*:* • Agency: Time allocation by gender • Market participation by gender • Achievements: Income by gender • Nutrition/Food security by gender • Health status by gender • Level and reliability of social support with gender integration	ICRISAT
Human Condition: • Dietary diversity, Availability of diverse food crops, Food consumption score, Nutritional status (underweight, stunting, wasting and Uptake of essential nutrients • % of households experimenting	SUA

Deliverables:	*Means of verification*	*Delivery date*
Training/technical capacity conducted	Report	September 2019
Drivers of food choice in Kongwa, Kiteto, and Babati established	Report, draft manuscript	September 2019
Household awareness and knowledge on complementary feeding, hygiene practices and aflatoxin mitigation documented	Report Draft manuscript	eptember 2019

How will scaling and sustainability be achieved? Through partnerships with the government and development partners to address gaps identified on food choice and utilization
How are the activities in this protocol linked to those of others?

Multi-team participation will be adapted during the implementation process to explore the synergies between the crop production and nutrition teams in influencing food choice and utilization				
Sub-activity 3.2.1.2 Promote farmer production of nutrient dense (Zn, Fe) SER83 and NUA45 bean varieties produced by CIAT during 2018.				
Systems research team:				
Name	*Institution*	*Role*		
Chirwa R	CIAT	PI, bean integration		
Agnes Mwangwela	LUANAR	Nutrition outcome tracking studies/food quality/safety		
	DADO offices	Backstop R4D activities		
Students:				
Name	*Institute*	*Degree*	*Start*	*End*
Frank Chilanga	LUANAR	MSc Nutrition	2018	2020
Locations:	Linthipe EPA, Malawi			
Start date	January 2017			
End date	September 2021			
Justification: The introduction of nutrient-dense common bean varieties is meant to provide a good source of both protein and micronutrients (Fe and Zn) that are essential for improved human nutrition (human condition domain). The improved germplasm will be evaluated for performance in intercrop with maize and be rated by gender through focus group discussions and surveys.				
Objectives: 1. Which bean varieties, bush or climbing fit best in the maize-based cropping systems to supply better quantities of combined maize and bean grain for human food (calorie), nutrition (protein) and income security? 2. Does access to and use of nutrient dense common bean varieties result in improved human nutrition outcomes 3. What is the social acceptability of improved common bean varieties (taste, cooking time, etc.) versus traditional varieties? 4. What are the nutritional quality and bioactive properties of bio-fortified beans? 5. What are the cooking characteristics and how acceptable (social, economic and sensory)				
Experiment design, implementation and data analysis: This experiment will test the combination of maize with two types of common bean growth habits (bush and climbing). Within each bean growth habit, there will be two types of varieties which have been selected on purpose. Among the bush bean category, both varieties are already released in Malawi, where SER83 is known for drought tolerance, and NUA45 is known for nutrition - biofortified (high Fe and Zn content). In the climbing bean category are a local variety (Domwe wawilira) and a new test variety (MAC109). To compare maize with maize/bean intercrop treatments, one plot will be planted to maize pure stand. Likewise, to compare bean/maize intercrop with bean only, the whole				

set of bean varieties will be planted in pure stand, where the climbing bean will be supported by stakes. The climbing beans are more vegetative and so they provide more biomass yield than bush bean. The experiment will use the mother and baby approach, where the mother sites will be researcher managed and will have a complete set of 9 treatments, replicated 4 times. The baby trials will be farmer managed and will have a sub-set of 5 treatments each, without replication. The farmers will be sampled from a group of farmers who are participating in the goat feeding project. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.		
Data (with metrics) to be collected and uploaded on dataverse		
SI Domains		**Responsible institution**
Productivity: Bean grain productivity (kg/ha/season), bean biomass productivity (kg/ha/season); variability of production (CV);		CIAT
Environmental*:* biological N2-fixation (kg N/ha/season)		CIAT
Economic*:* Profitability of growing different varieties of improved common beans (Gross margin in $/ha/season; Benefit-Cost Ratio)		CIAT
Social: Farmer acceptance of different bean varieties (rating of technologies by gender); Market participation by gender		CIAT, LUANAR
Human Condition ***:*** Protein production (g/ha); micronutrient production (g/ha)		CIAT, LUANAR
Deliverables:	*Means of verification*	*Delivery date*
Nutrient-dense common bean seed distributed to about 500 farmers	List of farmers involved by site, disaggregated by sex	January 2019
At least 3 mother trials and 20 baby trials per mother established	Field trials established	January 2019
Yield distribution/range for common bean production using improved germplasm	Excel files with yield survey data	June 2019
At least 3 feedback meetings held with farmers between March and August 2019	Reports on meetings with farmers	September 2019
Estimates of productivity and yield gaps for local and improved bean varieties	Scientific draft publication	September 2019
How will scaling be achieved? When the seed of these varieties becomes widely available, the Ministry of Agriculture that is already being exposed to the technology will disseminate to other bean growing areas. CIAT also uses the Southern Africa Bean Network for scaling.		
How are the activities in this protocol linked to those of others? The LUANAR Nutrition Department will study the nutrition outcomes among households utilizing nutrient-dense common bean varieties produced from this protocol		
Sub-activity 3.2.2.3		

Determining quality and safety of locally produced legume grain-derived complementary foods and adoption in Dedza District

Research team:

Name	*Institution*	*Role*
Agnes Mwangwela	LUANAR	PI, Nutrition outcome tracking studies/food quality/safety
Rowland Chirwa	CIAT	Nutrient-dense common bean production research component

Students:

Name	*Institute*	*Degree*	*Start*	*End*
Kondwani Luwe	LUANAR	MSC Human Nutrition	2018	2020
Melise Mwachumu	LUANAR	MSc Food Science & Technology	2018	2020
Sunganani Chowa	LUANAR	MSc Human Nutrition	2018	2020

Locations:	Linthipe EPA
Start date	January 2014
End date	September 2021

Justification:

Farming households produce maize, soybeans, common beans, groundnuts and goats; yet the prevalence of child malnutrition and low dietary diversity are still high. This study explores a pathway to harness the nutritional outcomes out of the agricultural intensification intervention.

Objectives:

Demonstrate how the complementary foods that utilize readily available nutritious ingredients protect children from undernutrition

Experiment design, implementation and data analysis:

The main study is designed as a randomized controlled feeding trial in Dedza. The study will examine the efficacy of three complementary foods for improving the nutritional status of children. Ninety children aged 8 to 12 months old will be randomly allocated to three supplementary food interventions:

a. Maize – soyabean flour blend– *(the current recommended complementary food)*
b. Maize – goat powder blend, and
c. Maize – nutrient dense bean flour blend

The caregivers (male and female) will participate in community learning and growth monitoring sessions (CLGM). The study is designed to run for 12 Months starting January 2019. The project will start as soon as National Health Research Committee approves the protocol. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on dataverse

SI Domain	**Responsible institution**

Productivity: NA		
Environmental: NA		
Economic: Food processing labor requirement (hours per meal for 6 persons		LUANAR
Social: Nutrition/Food security by gender; Capacity (access to information); Rating of technologies by group		LUANAR
Human Condition: Availability of diverse food crops; Food safety of finished products (aflatoxins (micrograms/kg); Dietary diversity; Uptake of essential nutrients; % of farmers experimenting		LUANAR
Deliverables:	*Means of verification*	*Delivery date*
• Improved household utilization of nutrient-dense recipes	Technical report. Draft manuscript	August 2019
• At least 2 field days held with nutrition groups, especially HIV/AIDS action groups in Linthipe, jointly with DNCC	Field day reports	September 2019
• 3 recipes available	Recipe booklet	September 2019
• Improved child nutrition status demonstrated	Report: Anthropometry and infant and young child feeding	September 2019
How will scaling be achieved? Collaboration with District Nutrition Coordinating Committees (DNCC) to disseminate the recipes beyond Africa RISING intervention sites/EPAs		
How are the activities in this protocol linked to those of others? Legume grain used in nutrition training and value addition is derived from other components of the project, e.g. CIAT introduced nutrient dense common bean varieties		

Outcome 4: Functionality of input and output markets and other institutions to deliver demand-driven sustainable intensification research products improved

Output 4.1: Access to profitable markets for smallholder farming communities and priority value chains facilitated

Activity 4.1.1: Conduct comprehensive value-chain analysis with specific focus on SI technologies		
Sub-Activity 4.1.1.1 **Conduct value chain analysis (VCA) for (nutrient dense) maize seed in Kongwa and Kiteto**		
Research team:		
Name	Institution	Role
Bright Jumbo	CIMMYT	PI
Patrick Okori; James Mwololo	ICRISAT	To work closely on similar ICRISAT led VCA for cereals (Sorghum) and legumes (groundnuts)
Anicet Sambala	IITA	M&E Support
Gundula Fischer	IITA	Provide guidance on gender when designing tools (questionnaires) for the maize value chain study that are gender inclusive
Students: Nil		
Locations:	The following target villages in Kongwa, Kiteto and Iringa will be used: Ismani, Igula, Kihorogota, Ndoela, Mlali, Sagara and also some marketplaces in Dodoma (Kongwa), part of Iringa and Manyara (Kiteto)	
Start date	October 2018	
End date	September 2019	
Justification: Challenges of quality seed for quality protein (QPM) and Pro-Vitamin A maize can be addressed through a better understanding of the linkages between farmers, traders, processors, exporters and other actors along the value chain. The seed value chain concept is the systems sequence of related business activities (functions) from the provision of specific inputs for a particular product to primary production, transformation, marketing and up to final consumption. Drought tolerant QPM hybrids were tested and validated in Kongwa and Kiteto and had more than 5 times higher yield advantage than the old QPM and non-QPM hybrids under water stress conditions. A cost-benefit analysis also showed that QPM had higher profitability compared to non-QPM. The value chain of their seed needs to be established so as to facilitate informed production, supply and consumer participation in the maize seed production and marketing.		
Objective: To generate information on insights surrounding production, input supply, traders, consumers, and establishing the linkages and challenges surrounding the value chain.		
Experiment design, implementation and data analysis: The study will be conducted through interviews and surveys using structured questionnaires, and SPSS will be used for data analysis. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.		

Data (with metrics) to be collected and uploaded on Dataverse	
SI Domains	**Responsible institution**
Productivity: Information on Yield (kg/ha/yr) maize varieties grown through survey interviews with producers/farmers	CIMMYT
Environmental: Plant diversity (varieties). Types of varieties grown by farmers in target areas.	CIMMYT
Economic: Profitability/Gross margins (USD), nutrient dense maize vs regular maize, consumer information (demand), input supply information, grain market information, producer information in the VC	CIMMYT
Social: Equitable participation (Gender equity) in production, input supply, and seed marketing chains, collective groups	CIMMYT
Human Condition: Nutrition awareness, Community awareness on nutrient-dense maize varieties, seed supply; capacity of the community to participate in the production, input supply and seed market	CIMMYT

Deliverables:	*Means of verification*	*Delivery date*
Information on main actors on production, input supply, and market participation known	Project progress reports, survey reports	September 2019.
Profitability of nutrient-dense hybrids vs regular hybrids analyzed	Gross margin analysis results	September 2019.
Information on equitable participation in production, input supply, seed demand, and market participation known	Project reports	September 2019
Community awareness, Community Knowledge about production, input supply and market opportunities known	Survey reports	September 2019

How will scaling be achieved?
Engagement of seed companies & agrodealers through variety release, commercialization and delivery of certified seed to local market outlets accessible by local farming communities in Kongwa and Kiteto.

How are the activities in this protocol linked to those of others?
To realize hybrid yield potential, good agronomic combined with good soil and water conservation practices are critical. Choice agronomic practices for the new varieties are validated with the S&WC (TARI-Hombolo) and ISFM protocols (SUA). Results from validated agronomic studies and soil and water conservation studies will be packaged together with the output from this study and available for scaling.

Sub-activity 4.1.1.2
Value chain analysis of groundnut seed and design of operation enhancement strategies for semi-arid ecologies of central Tanzania

Research team:

Name	*Institution*	*Role*
James Mwololo	ICRISAT (PI)	Coordinate assembly of data from both research and monitoring activities. Engage with other Africa RISING local and CGIAR partners
Anicet Sambala	IITA	M&E Support
Extension officers	DAICOs-Iringa, Kiteto, Kongwa	Support the survey teams (enumerators) as appropriate

Locations:	Chitego and Mlali Njoro or Kiperesa and either Laikala or Moleti and Igula villages in Kongwa, Kiteto and Iringa Districts of Tanzania
Start date	2019
End date	2019

Justification:

Limited access to improved seed of open-pollinated crops by rural smallholder farmers could be addressed through a better understanding of the key drivers and impediments of the seed value chains as it enables elucidation of system functions from production to delivery of seed products and services i.e. primary production, transformation, marketing and up to final use of the seed by farmers. Such an analysis would unravel linkages between farmers, traders, processors, exporters and other actors. Crops with open pollination biology (OPVs) and self-pollination tend to be less attractive to commercial seed companies. Africa RISING has developed new resilient and highly productive drought-tolerant maize, sorghum, pearl millet, groundnut and have open pollinated QPM and medium maturing pigeonpea varieties. These materials will clearly have limited traction, especially for private sector investment. There are however few agro-dealers in the target zone of influence who mostly trade in hybrid varieties and limited open-pollinated varieties of our focus crops. A key goal of Africa RISING is to sustainably increase productivity in the semi-arid ecologies of Tanzania. Therefore, how to strengthen seed value chains of our focus crops is one of the critical areas of R4D. An expanded description of the justification is given in the Research Protocols 2018-2019 – Appendix 1.

Objective:

Determine the challenges and opportunities influencing the effective functioning of groundnut seed value chain in central Tanzania.

Research questions:

1. Who are the critical groundnut seed value chain segment actors in central Tanzania and what are their roles in the input and output markets?
2. What are the critical factors that influence seed value chains of groundnut?
3. What are the critical elements of a "well-designed seed value chain development initiative" that strengthen marketplace systems, and does not negatively distort or displace private sector investment flows for central Tanzania?

Experiment design, implementation and data analysis:

The studies will be done in three districts namely Kongwa, Kiteto and a comparator district Morogoro and or Babati for maize. The comparator districts have relatively stronger access to agro-input

services. Different stakeholders across the value chains in three of the study districts will be engaged extensively to map the value chains and develop the strategy for improving its functionality. Data collection tools and or approaches will include A desktop study of the context; field- farmers, input suppliers, financial service providers, market players, Government authorities. A stratified random sampling method will be used to select farmers, and snowball sampling used to identify other stakeholders. Farming systems surveys/focus group discussions/Key informant interviews/stakeholder meetings that focus on producers, aggregators, policy agencies and actors, gender and business concerns will be conducted. This will enable to the team to identify, analyse and share the subtle lessons behind the success and/or failures in specific commodity seed value chains while at the same time unveiling the key opportunities to make them vibrant. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.		
Data (with metrics) to be collected and uploaded on Dataverse		
SI Domain		Responsible institution
Productivity: • Crop productivity: Seed yield (kg/ha/season)		ICRISAT
Environmental: NA		
Economic: • Profitability: Net income ($/crop/ha/season), Gross margin, Net income (total net income from strengthened seed value chain projected/quantified)		ICRISAT
Social: • Collective action: Participation in a collective action group in seed production and marketing; Capacity of groups to produce and market seed, Capacity of groups to engage in seed production • Equity: Access to resources, Capacity (access to info), Achievements (income, nutrition, food security, health, well-being), Value chain actor's perception on the importance of quality seed • Social cohesion: Level and reliability of social support in seed production, Incidence of social support in the seed value chain		ICRISAT
Human Condition: • Capacity to experiment: No. of new practices being tested, % of farmers experimenting		ICRISAT
Deliverables:	*Means of verification*	*Delivery data*
Groundnut seed value chain assessed and strategic areas for value chain strengthening identified	Study report and draft manuscript	30 September 2019
How will scaling be achieved? Through partnerships with government, the private sector and development partners to address the seed production gaps identified		
Activity 4.1.2: Conduct a value chain stakeholder analysis (stakeholder mapping)		

No sub-activity proposed for this year. Some stakeholder mapping activities were conducted before.
Activity 4.1.3: Develop a value chain enhancement strategy (including collective action approaches, contractual arrangements, and standardization
No sub-activity proposed for this year. Such activities to follow those implemented in Activity 4.1.1
Activity 4.1.4: Identify and evaluate existing mechanisms that inform farmers about dynamic market needs
MWANGA activities should be mapped here. Some of the activities were conducted before.
Activity 4.1.5: Conduct an analysis of the existing baseline survey data and supplement them with qualitative surveys from target regions
No sub-activity proposed for this year

Outcome 5: Partnerships for the scaling of sustainable intensification research products and innovations operationalized

Output 5.1: Opportunities for the use and adoption of sustainable intensification technologies identified for relevant farm typologies

Activity 5.1.1: Farmer participatory experimentation with crop and soil management and integrated crop-livestock technologies in on-farm situations		
Sub-Activity 5.1.1.1: Continuation experimentation in 6 target communities of Eastern Zambia and 10 target communities in central and southern Malawi with already established clustered CA trials		
This sub-activity is formatted differently, and best described in Research Protocols Appendix 2		
Sub-Activity 5.1.1.2: Explore the productivity domains of selected legumes and cereals to elucidate their best fitting cropping system at community/landscape level and their dissemination		
Systems research team:		
Name	**Institution**	**Role**
Patrick Okori	ICRISAT (PI)	Coordinate the assembly of data from both research and monitoring activities
Anicet Sambala	IITA	M&E Support
TARI technicians; Extension officers	ARI Hombolo/Iringa, Kiteto, Kongwa, DAICO offices	Backstop field days and other limited field monitoring activities as required
Locations:	Chitego and Mlali, Njoro or Kiperesa and either Laikala or Moleti and Igula Villages in Tanzania	
Start date	2014	
End date	2019	
Justification: A number of cereal and legume crops are produced in the semi-arid ecologies of central Tanzania. Under Africa RISING the team has developed varieties that produced over 50% yield advantage over local landraces (Okori et al. 2014, 2018). We have also evaluated a few cropping systems and found variation (Okori et al 2014). Saxena et al. (2018) report that whereas intercropping pigeonpea system accounts for over 70% of the pigeonpea area, the grain yields in these systems are very low (400–500 kg/ha) in part due to poor adaptation of varieties to intercropping. This is expected given that the crop is photoperiod sensitive and therefore maturity periods will invariably affect suitability for intercropping. In other intercropping studies, non-adaptability of sorghum and groundnut has been reported. In maize-legume mixed cropping, intercropping is more beneficial in less fertile fields and in more marginal environments with both varietal and crop differences. Two experiments will be conducted to inform the integration of highly productive legume and cereal genotypes into the cropping systems of semi-arid central Tanzania		
Research questions: 1. To what extent do superior legume and dryland cereal varieties improve the productivity of cropping systems in the dryland ecologies of central Tanzania?		

2. How do the varieties and associated technologies affect the livelihood choices and options adopted by farming communities?

Experiment design, implementation and data analysis:
Two researchers managed trials that have all treatments will be mounted. In each village, the effect of only one sub-agroecological condition will be tested in either of the districts, Kongwa, Kiteto and Iringa. The location will be determined by land availability and resource management. Thus, we will have one village in the high potential (either Chitego or Mlali); b) Njoro or Kiperesa for the moderate potential sub-agroecology and Laikala or Moleti for Kongwa or Igula in Iringa for the low potential sub ecologies. The treatment structure will comprise the treatments 4 crops X varieties (3-4) X environemnts (stressed vs non-stressed) X planting time (early vs late). An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on Dataverse

SI Domains	***Responsible institution***
Productivity: • Crop productivity: Yield (kg/ha/season) • Crop biomass productivity: Residue production (kg/ha/season) • Input use efficiency: Product per input	ICRISAT
Environmental: • Fuel availability: Fuel biomass (e.g., wood, residues) produced on plot, % household fuel by type (wood, charcoal), participatory exercise Biomass measurement • Plant biodiversity: Alpha Diversity Index • Pesticide use: Active ingredient/ha	ICRISAT
Economic: • Profitability: Net income ($/crop/ha/season) • Labour requirement (hours/ha)	ICRISAT
Social: NA	ICRISAT
Human Condition: • Capacity to experiment: Number of new practices being tested, % of farmers experimenting	ICRISAT

Deliverables	*Means of verification*	*Delivery date*
Performance of superior varieties in target communities established to inform technology scaling-up and integration	Report on variety performance (grain yield, net economic benefits).	September 2019
Performance of different legume-cereal cropping systems in three sub-ecologies of the Semi-Arid zone of central Tanzania established	Progress reports, draft manuscript for publication in peer-reviewed journal	September 2019
Technologies out scaled and upscaled	Reports on: Number of field days held; Number of farmers directly	September 2019

	involved; Partners engaged	

How will scaling be achieved?
Through partnerships with government and development partners to promote the technologies widely post the project
Through field days and promotional campaigns

How are the activities in this protocol linked to those of others?
A multi-team participation will be used leveraging on complementarities and to explore the synergies among GIS (IITA), soil and water conservation (Hombolo) and integrated soil fertility management (SUA) protocols of teams working in Kongwa/Kiteto

Sub-Activity 5.1.1.3
Engage development partners to identify technologies of interest for partnership dissemination

Research team:

Name	*Institution*	*Role*
Ben Lukuyu	ILRI	PI
Leonard Marwa	ILRI	Technical backstopping on preparing and delivering livestock messages
Extension representative	Extension staff – Babati district	Monitor and provide intelligence about partner activities
Development partners	World Vision COSITA, FIDE	Training on our technology packages using our training materials.

Students: Nil

Locations:	All villages, Babati District
Start date	2017
End date	2020

Justification:
This activity will major involve one-on-one meetings with development partners whom we have already identified through our previous stakeholder meetings, to identify which technology/gies they are interested in / or are currently engaged in and would like to take to scale (including financially supporting the process). Once these are identified, Africa RISING will define detailed plans and explore potential to develop MoUs that will outline activities and expected deliverables.

Objectives:
To plan and roll out various livestock scaling activities with partners

Experiment design, implementation and data analysis:

ILRI's role will be to develop the Development Partners' capacity in the ability to understand, demonstrate and scale the technology and back-stop their scaling if necessary, and address research needs as they are identified in the process
Data (with metrics) to be collected and uploaded on Dataverse: Not applicable

Deliverables:	*Means of verification*	*Delivery date*
Meetings with selected partners	Meeting reports and activity outlines for partners	March 2019
Monitoring of training activities	Training reports from partners	July 2019
Number of technologies taken to scale	Report to IITA	
MoU with at least one development partner for a longer-term relationship	Report to IITA	August 2019

Activity 5.1.2: Use farm trial data to apply crop simulation models and assess performance over space and time, including assessment of climate-smart technologies to establish the potential for adaptation and mitigation

Sub-activity 5.1.2.1:
Apply APSIM crop simulation model to assess changes in resource use efficiencies, productivity and profitability of the different cropping systems in Kongwa, Kiteto and Iringa in Tanzania

Research team:

Name	*Institution*	*Role*
Patrick Okori	ICRISAT	PI
Amos Ngwira	ICRISAT	Coordinate assembly of data from both research and monitoring activities. Engage with other Africa RISING agronomists for cross-site studies
Anicet Sambala	IITA	M&E Support
TARI Technicians; Extension Officers	ARI Hombolo/Iringa, Kiteto, Kongwa, DAICO offices	Backstop field days and other field monitoring activities as required.

Locations:	Kongwa, Kiteto, Iringa: Chitego and Mlali, Njoro or Kiperesa and either Laikala or Moleti and Igula
Start date	2019
End date	2019

Justification:
Agricultural production in eastern and southern Africa is constrained by numerous factors. Amongst them are frequent droughts and in-seasonal dry-spells, declining soil fertility, excessive water run-off and soil erosion, unsustainable land-use practices and limited adoption of improved agricultural

technologies (Thierfelder *et al.*, 2015). Climate projections for eastern and southern Africa until 2050 suggest temperature increases by on average 2.1-2.7°C (Cairns et al., 2013), which will lead to a delay in the onset of the rainy seasons and increased extreme events (e.g. excessive rainfall and drought stress). Lobell et al. (2008) argue that identifying adaptation measures to reduce the potential negative impacts of climate change on crops is important to secure food production. Potential adaptation measures include deployment of improved germplasm tolerant to drought, heat stress and amenable to improved agronomic practices (Cairns et al. 2013). Thus, there is a need to deploy integrated crop management solutions to adapt varieties and cropping systems to diverse farming systems and increasing weather variability. To accomplish this across broad geographic areas, it is imperative to determine how improved cereal-legume varieties and different crop management systems will be affected by weather variability including market risks and how to select and implement the most viable systems on smallholders' farming systems

However, traditional experiments aimed at deriving appropriate cropping practices for the wide variety of soil types and climatic conditions are time-consuming and expensive. In this context, use of crop simulation models (CSMs) is often considered useful to simulate different soil and crop management and climatic scenarios for developing the most suitable and site-specific strategies (Jones et al. 2003; Rezzoug et al. 2008). In Africa, modelling-assisted discussions among scientists and between scientists and farmers have provided a useful framework for designing field research for highly variable production environments; providing an opportunity for learning about new technologies and practices (Carberry et al. 2004) or exploring options for the sustainable intensification of production in smallholder farmers (Tittonell et al. 2009). Crop simulation models have become more useful with the incorporation of decision support systems that aid risk assessment and economic analyses of management strategies. An expanded description of the justification is given in the Research Protocols 2018-2019 – Appendix 1.

Objectives:

1. To calibrate and validate APSIM model to predict the yield of improved varieties of cereals and legumes using data generated through on-farm experimentation
2. To assess the long-term implications of sustainable intensification options on climate and market risks and resource use efficiency of smallholder farms in central Tanzania and Malawi
3. Identify and propose proven climate resilient practices which will be applied to enhance the resilience of the cereal and legume value chains to climate change and help to minimize climate risks and stabilize production and yields

Experiment design, implementation and data analysis:

The studies will be done mainly in central semi-arid ecologies of Tanzania in Dodoma and Malawi. The work builds on ongoing Africa RISING activities in Kongwa and Kiteto districts in Tanzania as well as Dedza and Ntcheu districts in Malawi. Soils in this zone are mainly sandy and loamy of low fertility and seasonally waterlogged or flooded clays. The average annual rainfall is 589 mm but the distribution is highly variable with high intensities. The average annual temperature is 22.7°C.

The study will collate existing and relevant datasets on soil and climate to calibrate APSIM for modelling of intercropping systems to establish their potential to adapt and mitigate the negative effects of climate change; soil sampling and analyses, and detailed data collection on crop data from the established intercropping trials in Tanzania and Malawi for parameterisation of APSIM. These will

form the basis for future model validation and evaluation. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on Dataverse

These will be generated through simulation	*Responsible institution*
Productivity: • Crop productivity: Yield (kg/ha/season) • Crop biomass productivity: Residue production (kg/ha/season) • Input use efficiency: Product per input	ICRISAT
Environmental: • Fuel availability: Fuel biomass (e.g., wood, residues) produced on plot • Soil physical quality: Bulk density • Soil chemical quality: Soil nutrient levels	ICRISAT
Economic: • Profitability: Net income ($/crop/ha/season) • Labour requirement (hours/ha)	ICRISAT
Social: NA	
Human Condition: NA	

Deliverables:	*Means of verification*	*Delivery date*
Long term implications of intercropping systems on climate and market risks and resource use efficiency of smallholder farms assessed	Reports/publication/extension materials	30 Sept 2019
	Report on the number of candidate crops and their agronomy options	30 Sept 2019
Farmer perceptions on technology options	Report on prioritized farmer technology preferences	30 Sept 2019

How will scaling be achieved?

Through partnerships with government, researchers and development agencies to adapt modelling insights into sustainable intensification technologies. Also, through publication for further use of the knowledge in program designs.

How are the activities in this protocol linked to those of others?

Multi-team participation will be adapted during the implementation process to explore the synergies on modelling among GIS (IITA), soil and water conservation (Hombolo) and integrated soil fertility management (SUA) protocols of teams working in KK.

Activity 5.1.3: Establish adaptive field experiments with mineral and crop/animal-derived organic manure

Sub-Activity 5.1.3.1:

Rainfall-responsive nitrogen fertilization strategies: in search of increased nitrogen use efficiency by smallholder farmers under rainfed conditions

Research team:

Name	*Institution*	*Role*

Regis Chikowo; Sieg Snapp	MSU	PIs, research conceptualization and implementation
Julius Manda	IITA	Backstopping on economic evaluation
Anicet Sambala	IITA	M&E Support
Lieven Claessens	IITA	Ex-ante impact assessment with Tradeoff Analysis Model for Multi-Dimensional Impact Assessment (TOA-MD) for regional relevance of Africa RISING technologies
Students: Nil		
Locations:	Lithipe, Kandeu, Mtubwi, Nsanama, Nyambi, Extension Planning Areas (EPAs), Malawi	
Start date	October 2017	
End date	September 2020	

Justification:

Agricultural intensification invariably requires efficient use of resources. This is especially so for resource-constrained farmers in developing countries. While it is known that nitrogen (N) fertilizers recovery by crops is intricately linked to soil water availability, current N application strategies, especially when urea-N is used, barely reflect the necessity for reduced N application when rainfall fail or more N application when the season is favorable. For farmers who invest in N fertilizers, the high risk for financial losses associated with drought-induced crop failure is often beyond the threshold that these farmers can absorb. Thus, financial risk reduction must be at the core in formulating innovations around N fertilizer use by smallholder farmers.

Objectives:

1. To determine the effect of the rainfall-responsive application of side dressing N fertilizer to nitrogen use efficiency across a rainfall gradient
2. To determine the effect of soil type in the application of the rainfall-responsive N fertilization strategy

Experiment design, implementation and data analysis:

This experiment was initiated during the 2017/2018 cropping season in Machinga district Ntubwi, Nsanama, Nyambi). Treatments for this experiment are shown in Table 1 and replicated three times per site. This experiment will be repeated during 2018/19 season Machinga and two additional high potential sites (Linthipe and Ntiya).

Nutrient deficiencies, especially P, are known to limit uptake of N by crops. Therefore, we reduced P limitations across all treatments through a blanket application of 10 kg ha-1 P as single super phosphate or NPK compound fertilizer. Treatments 2-9 received 23 kg ha-1 N at planting as ammonium nitrate. Additionally, treatments 3-9 received one or two side dressings of 23 kg ha-1 N, designated as low rate [L] or high rate [H] at 46 kg ha-1 N as ammonium nitrate. For example, Treatment 5 [92N-LH) received a total of 92 kg N ha-1, in the form of 23 kg N at planting plus two further applications of 23 kg and 46 kg at 4 and 6 WAE, respectively. The order of application of L and H side dressing N rates application is important, as this differentiates Treatments 5 and 7. Treatment 8 is similar to Treatment 4, with the 5 kg zinc applied as basal zinc sulphate as the sole difference. Treatment 9 is the non-fixed side dressing N application strategy – less N is applied when

rainfall is below normal or more is applied to a maximum of 138 kg/ha. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on dataverse	
SI Domain	**Responsible institution**
Productivity*:* Maize grain productivity (kg/ha/season), maize biomass productivity (kg/ha/season); variability of production (CV); nitrogen use efficiency (kg grain/kg N applied)	MSU
Environmental: Soil moisture availability (soil moisture by treatment)	MSU
Economic: Profitability- Gross margin in $/ha/season; Benefit-Cost Ratio; Farmers' rating of labor (related to labor for multiple N side-dressing)	MSU and IITA
Social*:* Rating of technologies by gender	MSU
Human Condition: Food security (calorie production kg/ha/season)	MSU

Deliverables:	*Means of verification*	*Delivery date*
• Field experiments established	Field plans, protocols	January 2019
• Soil moisture probes installed on at least 2 sites	Probes physically in the field; data downloaded every month	April 2019
• Field days held with partners	Field day reports	May 2019
• Soil water and nutrients use interactions assessed	Draft publication	September 2019

How will scaling be achieved? This technology can be scaled countrywide through an existing Airtel 321 agriculture information service, therefore once efficacy proved, the next step would be to engage Airtel, as well as the national Extension Services of the Ministry of Agriculture
How are the activities in this protocol linked to those of others? This is a novel system not yet widely used. We are piloting the technology. However, all other protocols are using the same principle on increasing resource use efficiencies
Sub-Activity 5.1.3.2: Assessing the effect of residue quantity and quality, and water conservation on maize productivity and nitrogen dynamics on smallholder farms in Malawi

Research team:		
Name	Institution	Role
Regis Chikowo; Sieg Snapp	MSU	PIs, research conceptualization and implementation
Julius Manda	IITA	Backstopping on economic evaluation
Anicet Sambala	IITA	M&E Support
Lieven Claessens	IITA	Ex-ante impact assessment with Tradeoff Analysis Model for Multi-Dimensional Impact Assessment (TOA-MD) for regional relevance of Africa RISING technologies

Students				
Name	*Institute*	*Degree*	*Start*	*End*
Chiwimbo Gwenambira	MSU	PhD	2016	2020

Locations:	Lithipe, Kandeu, Mtubwi, Nsanama, Nyambi, Extension Planning Areas (EPAs)
Start date	October 2016
End date	September 2021

Justification:

May soils on smallholder farms in Malawi have poor soil organic matter content. This results in poor maize productivity when sufficient mineral fertilizers are not added. Building soil organic matter requires improving both cereal and legume crops primary productivity through mineral fertilizers and retaining the associated crop residues on the cropped lands. These residues decompose to provide mineral N to crops grown in sequence, as well as being an important source for SOM capitalization. Residues of legumes crops have a narrow C/N ration and are hypothesized to improve N cycling and benefit the rotational crop, whereas residues of maize, which have a wide C/N ratio, promote immobilization. While this knowledge is widely known, what is not clear is the interaction between crop residue quality, quantity and soil water management on maize productivity and mineral N dynamics.

Research questions:

1. Does incorporating soil water enhancing technologies increase/reduce the immobilization potential of maize residues?
2. What is the effect of varying the quantity of the crop residues incorporated (both maize and legumes) on mineral N dynamics, soil water content and maize productivity
3. For farmers with limited fertilizer use (50% NP), how detrimental is the use of maize residues (X0, X1, X2), with or without water conservation measures
4. What is the fertilizer substitution value of different quantity residues generated from a groundnut/pigeonpea doubled up system?

Experiment design, implementation and data analysis:

This study is based on investigating options that lead to both increased *productivity* and positive *environmental* benefits when crop residues are incorporated in soils at harvest time instead of being burnt. In this study, we generate both maize and legume crop residues in Year 1 and incorporate them in soils at harvest time. During Year 2, we assess the productivity of maize in all plots and conduct process studies to establish mineral N dynamics.

The experiment was implemented during 2016/2017 (Year 1) and 2017/2018 (Year 2) cropping seasons in Machinga and Mangochi districts at four sites. The residue generation phase will be repeated during 2018/19 cropping season, and the effects tested during the 2019/2020 cropping season in Linthipe, Ntubwi, Nsanama, Nyambi and Ntiya EPAs. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on dataverse		
SI Domain		**Responsible institution**
Productivity*:* Maize grain productivity (kg/ha/season), maize biomass productivity (kg/ha/season); variability of production (CV); nitrogen use efficiency (kg grain/kg N applied)		MSU
Environmental: SOC content, biological N2-fixation estimates		MSU
Economic: Profitability- Gross margin in $/ha/season; Benefit-Cost Ratio; Farmers' rating of labor		MSU and IITA
Social*:* Rating of technologies by gender		MSU
Human Condition*:* Food security (calorie production ha/season)		MSU
Deliverables:	*Means of verification*	*Delivery date*
• At least one field trial established in the 5 EPA study sites	Protocol, field plans available	January 2019
• Field days held with partners	Field day reports	May 2019
• Residue and nitrogen interactions assessed	Technical report	September 2019
How will scaling be achieved? This technology will be scaled countrywide through the National Extension Services of the Ministry of Agriculture; also, Total Land Care and other NGOs; One Acre Fund interested in residue utilization		
How are the activities in this protocol linked to those of others? CIMMYT uses mulching as one of the three pillars of conservation agriculture. CIMMYT experiments with conservation agriculture and crop residues being implemented in Machinga district		
Sub-activity 5.1.3.3 Assessing integrative effect of in-situ rainwater harvesting and fertilizer micro-dosing on crop yield, water and nutrient use efficiency in Kongwa District.		
Research team:		

Name	*Institution*	*Role*
Mawazo Shitindi	SUA	PI designing the research, supervising graduate student and overseeing the project activities
Anthony Kimaro	ICRAF	Support on maize legume intercrops and secondary data on fertilizer micro dosing and crop productivity.
Elirehema Swai	TARI Hombolo	Support on designing and managing rainwater harvesting infrastructures.
Julius Manda	IITA	Economics of integrating rainwater harvesting with fertilizer micro dosing
Gundula Fischer	IITA	Assessing social implications of integrating rainwater harvesting and fertilizer micro-dosing
Christopher Mutungi	IITA	Assessing nutritional value and food safety properties of maize, pigeon peas and ground nuts produced from the research

Anicet Sambala	IITA	M&E Support

Students:

Name	Institute	Degree	Start	End
Mushi Revocatus	SUA	MSc. Soil Science and Land Management	Jan. 2019	Nov. 2021

Locations:	Mlali village of Kongwa District and Njoro village of Kiteto District
Start date	December 2018 - new sub activity building on what has been done by TARI Hombolo and ICRAF since 2014
End date	November 2021

Justification:

Efficient use of every raindrop and nutrient applied in the form of fertilizer is therefore a prerequisite for food and income security of the population inhabiting semiarid lands. Improving water and nutrient use efficiency of cropping systems thus constitute key strategies for mitigating the negative impact of climate change on food and income security in semiarid lands. In-situ rainwater harvesting and fertilizer micro dosing technologies have been evaluated in Kongwa and Kiteto since 2017. Tied ridges and contours have been introduced and evaluated for soil erosion control in demonstration plots with farmers in Kongwa. Different fertilizer application rates have also been tested with farmers in Kongwa and Kiteto using two maize varieties and two fertilizer types and optimal N and P rates have been generated. The integrative effect of in-situ rainwater harvesting and fertilizer micro-dosing on crop productivity was not addressed.

Objective:

To evaluate the integrated effect of in-situ rainwater harvesting (tied ridges) and fertilizer micro dosing technologies on overall crop productivity, and water and nutrient use efficiency of maize-pigeon peas and maize–groundnut cropping systems

Experiment design, implementation and data analysis:

A split-split plot field experiment laid in a randomized complete block design will be implemented. Maize sole crop, maize – pigeon pea and maize – ground nut intercrops will be evaluated under two different water management systems (+/- tied ridges) with fertilizer rates of 0, ¼, and ½ and full maize recommended fertilizer rate in the area. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on data verse

SI Domains	**Responsible institution**
Productivity: Maize, pigeon peas and ground nut grain and stover or wood yield (t/ha/year); nutrient use efficiency (kg/g of fertilizer/nutrient used); rainwater use efficiency (kg of grain and biomass/mm/year)	SUA
Environmental: Crop nutrient uptake and nutrients exported out of the fields (kg/ha/yr)	SUA
Economic: Profitability of technology (gross margin in USD/ha); Cost-Benefit ratio (USD/USD).	IITA

Social: Feasibility and acceptability of the technology (numbers of farmers by gender and age groups) returns on labor investment (USD/person day); accessibility and use of fertilizers (kg/ha/individual farmer); number of farmers using fertilizers.	IITA
Human Condition*:* Nutritional value [protein and micronutrients (g/ha)] and food safety [aflatoxin analysis (µg/kg)] of the products to be done by IITA on produce samples collected during harvest	IITA - produce samples provided for analysis.

Deliverables:	*Means of verification*	*Delivery date*
Research protocol and work plan developed	Research protocols and work plan	December 2018
Farmers mobilized, experimental sites identified, and field experiments conducted	Reports on: Number of experiments conducted, and farmers involved in the research	31 August 2019
The feasibility of integrating in-situ rainwater harvesting and fertilizer micro dosing technologies	Assessment report	31 August 2019
Data sets for the first year (2018/2019) uploaded	Uploaded data set	31 August 2019.
At least two farmer field days and one research partner meeting conducted each year	Farmers field day and partner meeting reports	31 May 2019
Research results for year 1 presented at the annual project meeting and scientific conferences.	Presentations made	September 2019

How will scaling be achieved?
To scale this activity; development partner interested in the activity will be sought to help in taking it to scale.

How are the activities in this protocol linked to those of others?
Choice crop varieties for testing the proposed technology are validated with crop improvement (ICRISAT) and agronomic practices for the new varieties are validated with the S&WC (TARI Hombolo) and Fertilizer micro-dosing (ICRAF).

Activity 5.1.4: Demonstrate the use and impact of crop residues, forages, and other organic resources as animal feed and nutrient resources

Sub-activity 5.1.4.1
Test the effect of feeding Napier grass and Maize stover supplemented with bean haulms at different levels on milk yield under smallholder farmer conditions

Research team:

Name	*Institution*	*Role*
Ben Lukuyu	ILRI	PI

Leonard Marwa	ILRI	Implementing livestock feeding trials
Data collection clerks	To be recruited locally	Farmer mobilisation, full time data collection and entry and backstop farmer trainings

Students: Nil	
Locations:	Long, Sabilo and Seloto villages in Babati District
Start date	Continuation of feed trials that started during 2014
End date	2020

Justification:

In smallholder farming systems, the production of forage and fodder is often a sideline activity that is integrated with other areas of agricultural production. By growing and utilizing greater quantities of locally produced, high quality forages, livestock production costs can be reduced without compromising productivity, thus increasing on-farm sustainability. Introducing improved forages into small-scale mixed farming systems would reduce the competition for land because the same land is simultaneously used for both crop and forage production. Smallholder farmers in Babati District keep an average of 3-4 heads of cattle per household. These are mainly cross breeds (Zebu crossed with exotic dairy cattle) and a few pure breeds, mainly Friesian cattle. A feed assessment (FEAST) survey conducted in 2015, identified the availability of adequate feeds in terms of quantity and quality as one of the factors constraining smallholder dairy production. Following that assessment, an impact study of introducing crop residues (maize stover, bean haulms and pigeon pea haulms) into basal rations on milk yield under smallholder farmer conditions was conducted. The current study adds value to the feeding situation by testing the use of improved Napier grass, fed in combination with the different types of crop residues in basal rations on milk yield under the same smallholder farmer conditions.

Research question:

What is the impact of feeding Napier grass and Maize stover supplemented with bean haulms at different levels on milk yield under smallholder farmer conditions?

Experiment design, implementation and data analysis:

The experiment design includes: 2 dairy cattle genotypes (local and improved cattle) x 2 basal rations (Napier grass vs Maize stover, each supplemented with bean haulms at different levels of 100, 80, 70, 60 % on dry matter basis.

The experiment will be a complete factorial design with farms representing experimental units and lactating cows within a farm being replicates. A total of 32 cows in early lactation will be selected from two villages. Early lactation allows us to monitor increase in milk production and attribute it to feed. Initiate animal weight and stage of lactation data will be taken at the beginning f the trial and used to select and allocate animals to treatments. The experimental period will consist of a 7-day adjustment period and a 45-day data collection period. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on Dataverse

SI Domains		Responsible institution
Productivity: ***Animal productivity*** Milk (litres /animal /year) Rating of animal productivity		ILRI and UDOM
Economic: ***Profitability*** Profitability (gross margin of diets expressed in $/treatment ***Labor requirement*** Labor requirement (hours/day) Farmer rating of labor		ILRI and UDOM
Social: ***Gender equity*** Time allocation by gender Income by gender ***Equity*** Rating of technologies by group		ILRI and UDOM
Human Condition: ***Food security and nutrition*** Milk production at farm level expressed as calories/cow/year, and using available literature to derive protein output (g/cow)		ILRI
Deliverables:	*Means of verification*	*End date*
Ethical approval	Ethical approval certificate	February 2019
A total of 32 cows selected. Initiate animal weight and stage of lactation data taken at the beginning of the trial and used to select and allocate animals to treatments.	Report on farms and experimental cows' selection and allocation to treatments	March 2019
At least 25 trial farmers, 4 Extension and 1 data collection clerk trained on cow management, feeding procedure and data collection during the experiment	Training report	April 2019
Experimental diets evaluated by farmers	Evaluation report	June 2019
Nutritive value of diets evaluated	Nutritive value data set	July 2019
Feeding trials completed	Productivity data sets	August 2019
Data analysis completed	Technical report	September 2019
How will scaling be achieved? Partnership with COSITA and World Vision to deliver training about technology to 500 farmers		

Sub-Activity 5.1.4.2 Demonstrate the effect of home-made feed rations based on Gliricidia sepium and vegetable waste on productivity of selected strains of chickens		
Research team:		
Name	Institution	Role
Ben Lukuyu	ILRI	PI - ILRI
Leonard Marwa	ILRI	Research implementation
Chrispinus Rubanza	UDOM	PI – UDOM; sourcing experimental chicks
Mr. Mbesere	Extension staff – Babati district	Farmer mobilisation, training and backstop livestock feeding trials
	Extension staff – Kongwa, Kiteto districts	Farmer mobilisation, training and backstop livestock feeding trials
Students: Nil		
Locations:	Two villages (Babati district) and two villages (Kongwa, Kiteto districts)	
Start date	2014 (Building upon Phase I poultry nutrition studies)	
End date	2020	
Justification: A poultry nutrition Phase I study in Babati showed that feeding local chickens with home-made rations based on local feeds increased egg production by 26% and reduced mortality by 16%. This translated into an increased egg sales profit of 68% and live bird sales profit of 28%. In Africa RISING phase II, the livestock Babati team and working Kongwa/Kiteto team based at University of Dodoma and ICRAF will be testing these technologies further in a more holistic manner. In Kongwa and Kiteto, another study was initiated to address breed improvement and use of Gliricidia leaf as supplement in poultry feeding. These technologies will be integrated and implemented together in the current study; the synergies are expected from combined the breed selection and strengthening nutrition for improved performance of the rural chickens.		
Objective: To determine the effect of supplementing of *Gliricidia sepium* and vegetable leaf meal-based feed rations on production performance of selected improved chicken strains.		
Experiment design, implementation and data analysis: A complete randomized experimental design will be deployed to determine the effect of home-made rations on egg production, egg quality, growth rates and survival rates for one of the selected improved strains. Gliricidia and vegetable leaf meals will constitute 5, 10 or 15% of the rations as treatments. One farmer in each of 4 villages will host a treatment and be supplied with 54 test chicks. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.		
Data (with metrics) to be collected and uploaded on Dataverse		

SI Domains	Responsible institution
Productivity: ***Animal Productivity*** Animal products (eggs/chicken /year) Rating of animal productivity	ILRI, UDOM
Economic: ***Profitability*** Profitability (gross margin, based on egg production)	ILRI, UDOM
Social: ***Gender equity*** Rating of technologies by gender	ILRI, UDOM
Human Condition: ***Food security and nutrition*** Protein production (g/bird)	

Deliverables:	*Means of verification*	*Delivery date*
Ethical approval	Ethical approval certificate (ILRI)	February 2019
Experimental diets formulated and sampled	Evaluation report	April 2019
Feeding experiment set up	Quarterly progress report (ILRI)	May 2019
Nutritive value of diets evaluated	Nutritive value data set (ILRI)	July 2019
Experimental diets evaluated by farmers	Farmer evaluation report (ILRI/UDOM)	June 2019
Feeding trials completed	Productivity data sets (ILRI/UDOM)	August 2019
Complete data analysis	Technical report to IITA(ILRI/UDOM)	September 2019

How will scaling be achieved?
Partnership with COSITA FIDE and World Vision estimated to reach about 1000 farmers through the MWANGA platform

How are the activities in this protocol linked to those of others?
This activity is linked to the vegetable research by World Vegetable Centre and the manure management research by ILRI

Activity 5.1.5: Use crop-livestock models for trade-off analysis

No sub-activity planned for 2018-2019.

Activity 5.1.6: Disseminate best-fit integrated crop-livestock technologies to reach and have effect on small-scale farmers in a landscape context

Sub-activity 5.1.6.1:

Small-scale piloting of FarmMATCH – a framework for typology-based targeting and scaling of agricultural innovations. (Matching Agricultural Technologies to Farms and their context)

Research team:

Name	*Institution*	*Role*
Jeroen Groot	WUR	PI
VACANCY	WUR	Junior computer scientist for programming algorithms and data experiments
Francis Muthoni	IITA	Implementation and technical backstopping on data and recommendation domains
B. Haile	IFPRI	Technical backstopping on farm typology data
C. Azzarri	IFPRI	Technical backstopping on farm typology data
L. Claessens	IITA	Technical backstopping on data collection and recommendation domains

Students:

Name	*Institute*	*Degree*	*Start*	*End*
J.M. Delore	WUR	MSc	1-4-2019	1-9-2019

Locations:	Babati District (multiple villages)
Start date	2019
End date	2021

Justification:

Increasingly, mobile phones and other ICT services are used to provide information and advice to farmers to facilitate learning, but support to targeting and scaling of agricultural technologies through ICT tools is scarce. ICT-based targeting and scaling approaches should not be considered a silver bullet, although they can increase the reach and reduce the costs of technology dissemination compared to traditional village extension services. The actual adoption process and the implementation of new technologies should be supported by extension, training and teaching materials, and by enabling policies and institutional settings (Hermans et al. 2012; Wigboldus et al. 2016).

Sophisticated models of technology integration in farming activities exist, but they are often very data intensive and do not extend beyond the farm level (Le Gal et al. 2011). Muthoni et al. (2017) utilized spatially gridded biophysical and socio-economic layers to generate what they called "sustainable recommendation domains" (SRDs) that could be targeted for scaling specific technologies. Rubiano et al. (2016) applied extrapolation domain analysis to find areas with biophysical conditions similar to those observed in the pilot sites where SI technologies have been tested. However, these recent attempts do not consider suitability of the technologies at the household level. Farm- and household-level variation in socio-economic characteristics (e.g. education levels) is often excluded due to limitations in granularity of the spatial datasets used: the heterogeneity of households and farming systems within each spatial pixel is not adequately captured owing to the relatively coarse resolution of the spatial input data. The effectiveness of the suitability assessment can be further refined as long as the features of individual farms are considered and directly related to technology characteristics during the targeting phase. Innovations in coupling knowledge among site characteristics, household

features and technology attributes with the SRDs is needed to guide spatial targeting of suitable technologies.
Research questions: What are the most suitable and promising technologies for different types of farms? Where are the hotspots of suitability of technologies and potential adopters? Which contextual farm and technology characteristics promote the adoption and scaling of technologies?
Experiment design, implementation and data analysis: - Creation and further development of spatially gridded biophysical and socio-economic layers used to generate “Sustainable Recommendation Domains” - Development of the learning and matching algorithm that identifies which of the technologies tested and promoted by Africa RISING and its partners are most suitable and promising for different farm types in a given biophysical and socio-economic context. - Development of hand-held app and mirrored website for collection of geo-referenced farm data (8-10 variables). This approach will be piloted for ca. 10 grid cells in Tanzania (Babati). (Separately a similar assessment could be conducted in Africa RISIMNG West Africa, northern Ghana.) Data collection methods are described in the Research Protocols 2018-2019 – Appendix 1.
Data (with metrics) to be collected and uploaded on Dataverse. It should be noted that this activity does not aim to quantify the performance of farming systems in terms of the SIA indicators. Data collected are used to determine suitability to target innovations.

SI Domains	**Responsible institution**
Productivity: Crops productivity; cropping intensity	WUR
Environmental: Water availability and quality; soil cover; erosion; soil physical quality; soil chemical quality	WUR
Economic: Profitability; income diversification; market participation	WUR
Social*:* Equity; collective action	WUR
Human Condition*:* Food security; nutrition	WUR

Deliverables:	*Means of verification*	*Delivery date*
Report describing the experiment and algorithms performance	Report	30 Sept 2019
Coded algorithms for matching and signaling	Code	30 Sept 2019
Data for grid cells and generated recommendations	Data	30 Sept 2019

How will scaling be achieved?

The tool is potentially completely scalable and could be used by all farmers through their mobile device. Moreover, through the signalling function, it allows the identification of sites where extra support for scaling is needed in terms of market development, extension delivery, etc.
How are the activities in this protocol linked to those of others? This sub-activity is linked to: • Activity 1.4.1 Conduct extrapolation domain analysis based on GIS, agroecology, and crop model-generated information to establish the potential of technologies for geographical reach
Activity 5.1.7 Conduct cost-benefit and gender analysis coupled with other socio-economic analyses to identify and quantify adoption constraints and opportunities for different farmer contexts
All sub-activities listed under this Activity 5.1.7 are formatted differently, and are best described in Research Protocols Appendix 2
5.1.7.1: Socio-economic studies on cost/benefits of CA systems, GMCC and agro-forestry trials
5.1.7.2: Socio-economic studies on labour distribution and gender-related to CA
5.1.7.3: Socio-economic studies on nutritional benefits of SI practices

Output 5.2: Strategic partnerships with public and private, initiatives for the diffusion, and adoption of research products established

Activity 5.2.1: Map and assess relevant stakeholders to establish dialogue for the exploration of mutual synergies for scaling delivery of validated technologies		
Sub-Activity 5.2.1.1: Engage able and willing partners to develop a strategy and implementation framework for scaling up intensification technologies in semi-arid ecologies of central Tanzania		
Research team:		
Name	*Institution*	*Role*
James Mwololo	ICRISAT	PI. Lead engagement activities with partners as well coordinate assembly of data
Anicet Sambala	IITA	M&E Support
Extension officers	DAICO-, Kiteto, Kongwa	Backstop the AR and private sector as appropriate
Locations:	Kongwa, Kiteto, Iringa Districts (Villages: Chitego and Mlali (Kongwa District), Njoro or Kiperesa and either Laikala or Moleti and Igula)	

Start date	2014
End date	2019

Justification:
This sub-activity leverages on Innovation Platforms (IPs) established in 2014 in Kongwa and Kiteto. These (IPs) were set up to clarify technology end-use needs, integration and other socio-economic contexts (R4D entry points, lessons and partnership opportunities) for innovation and adoption. We have used them to inform the development of new crop varieties for sustainable intensification in Tanzania's semi-arid ecologies. Recently, groundnut and maize have been released, with sorghum and pearl millet in the pipeline for release as well. These technologies need to get into the hands of farmers, but are generally under-invested, especially by the private sector, and may, therefore, require multiple delivery mechanisms for success. Elsewhere, IPs have been used to provide multi-stakeholder mechanisms for technology delivery (Adekunle and Fatunbi, 2012). Since their establishment, the research team has mapped key stakeholders critical for improving the functionality of seed systems and allied agro-innovations in Kongwa and Kiteto. What is needed now, is to engage these partners for scaling-out innovations. An expanded description of the justification is given in the Research Protocols 2018-2019 – Appendix 1.

Research questions:
1. How does stakeholder engagement enhance delivery of technologies and productivity in farming systems?
2. What are the needed interventions to improve the functionality of multi-stakeholder-based technology generation to delivery systems?

Experiment design, implementation and data analysis:
The research team proposes to engage strategic stakeholders in an "experiential learning process" to develop and or strengthen groundnut and sorghum seed value chains in Kongwa and Kiteto. Critical for success is the power dynamics among actors, and how that could be leveraged to improve operations in technology delivery. We will develop MOUs with identified actors to test value chain strategies identified under sub activity 4.1.1.2, and work with them to investigate the power dynamics between them. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

SI Domain	Responsible institution
Economic: Profitability: Net income ($/crop/ha/season), Gross margin	ICRISAT
Social: Social cohesion: Incidence of social support to value chain and IPs by partners and stakeholders	ICRISAT
Human Condition: Capacity to experiment: Number of farmers experimenting, the percentage of women and men using the new technologies- assessed through surveys, focus group discussion, Number of new practices adopted, Technical capacity of partners	ICRISAT

Deliverables:	*Means of verification*	*End data*
Partnerships explored to improve delivery of underinvested legumes (groundnut) and cereals (sorghum)	Meeting Reports Partnership MoUs Study reports	30 September 2019
Imperatives for leveraging synergies of the private sector working with local communities to improve access to seed investigated.	Study report	30 September 2019

How will sustainability be achieved?
Through partnerships with government, the private sector and development partners to spearhead the scaling of technologies and innovations post-project

How are the activities in this protocol linked to those of others?
Multi-team participation will be adapted during the implementation process to ensure collective action for up-scaling and dissemination of technologies developed by the different institutions in the consortium

Activity 5.2.2: Leverage/link and integrate (engagement and outreach) with existent initiatives including Government extension systems to support and encourage the delivery pathways

Sub-Activity 5.2.2.1:
Engage with seed companies to accelerate QPM seed scaling

Research team:

Name	Institution	Role
Bright Jumbo	CIMMYT	PI
Anicet Sambala	IITA	M&E Support

Students: Nil

Locations:	Dialogue with seed companies covering Arusha, Dodoma, Iringa Regions of Tanzania
Start date	October 2018
End date	September 2019

Justification:
Drought-tolerant Quality Protein Maize (QPM) was tested and validated in Kongwa and Kiteto Districts of Tanzania and had more than 5 times higher yield advantage than the old QPM and non QPM hybrids under water stress conditions. A cost-benefit analysis also showed that QPM had higher profitability compared to non-QPM. Grain analysis for lysine and tryptophan, precursors for protein synthesis, showed that the new QPM hybrids had higher lysine and tryptophan.

Delivery of seed of improved maize varieties has mostly been done through the private sector (seed companies) and to a less extent public sector (particularly open pollinated varieties). Although there

are well established formal delivery channels, access to marginal and high-risk areas has not attracted much investment by the private sector to supply seed in these areas. Participation by seed agrodealers and extension networks provide viable outlets for seed in marginal or high-risk areas such as Kongwa and Kiteto. Utilizing existing development and extension networks could enhance rapid escalation of improved seed and enhance scaling. We plan to engage such development and extension networks to promote QPM.

Objective:
Identify and engage existing seed companies operating in the region to take up QPM scaling.

Research questions:
Can reaching out to existing networks/seed companies open for possible partnerships for scaling?

Experiment design, implementation and data analysis:
Engagement will entail discussions with seed companies during which Africa RISING will demonstrate how profitable the new QPM varieties are, by calculating gross margins (USD) of improved varieties vs regular varieties. We will use historical data coupled with data collected on QPM new hybrids obtained from our experiments in Kongwa and Kiteto.

Seed companies operating in the region usually work with agrodealers to sell seed. Discussions will also generate information of their links with agrodealers and how these agrodealers are engaged in the seed business and to know if agrodealers participation in seed distribution or trade is open, especially to women and youth.

Data (with metrics) to be collected and uploaded on Dataverse

This activity will allow presenting data from previous experiments during meetings, but not generating new data	Responsible institution
Productivity: NA	CIMMYT
Environmental: NA	
Economic: NA	
Social: Seed companies/agrodealers links enabling agrodealers participation in seed distribution or trade	
Human Condition: NA	

Deliverables:	*Means of verification*	*Delivery date*
1. MoUs with interested seed companies	Project progress reports, MoUs	August 2019
2. Promotions on QPM	Company field planning reports	August 2019
3. Increased interest in participation in AR field days by seed companies	Field day reports	August 2019

How will scaling be achieved?

This activity is part of the scaling process and successful engagement with the private seed companies has the potential for an increase in investment in QPM seed production/commercialization that could lead to increased access by farmers and increased adoption.
How are the activities in this protocol linked to those of others? Technologies on soil and water conservation and good agronomic practices are very critical support to maximize variety productivity potential, therefore approved/recommended new technologies on soil and water conservation as well as good agricultural practices will be packaged and linked to both QPM seed production by seed companies and QPM grain production by farmers at farm level.
The following three sub-activities are formatted differently, and are best described in Research Protocols Appendix 2
Sub-Activity 5.2.2.2: Support to CRS to conduct 24 on-farm trial replicates using different GMCC and grain legume intercropping strategies
Sub-Activity 5.2.2.3: Support to CRS in scaling and marketing of GMCC and grain legume systems in Chipata and Lundazi
Sub-Activity 5.2.2.4: Support to Total LandCare in scaling CA systems in Malawi
The following two sub-activities are formatted differently, and are best described in Partnership Collaboration Agreements, Appendix 3
Sub-acttivity 5.2.2.5: Partnership with Islands of Peace for increasing the adoption of post-harvest management practices
Sub-Activity 5.2.2.6: Partnership with Islands of Peace for increasing the adoption of good agricultural practices (GAP) in vegetable production and improving nutrition

Output 5.3: Gender-sensitive decision support tools for farmers to assess technology-associated risk and opportunities used by partners

Activity 5.3.1: Identify and communicate gender-sensitive decision support technologies in the context of different farm typologies		
5.3.1.1: **Socio-economic and gender implications of cereal-legume technologies**		
Research team:		
Name	*Institution*	*Role*
Anthony Kimaro	ICRAF	PI, research design and oversight of project activities

Emmanuel Temu	ICRAF	Contribute to socio-economic, gender and labor studies
Julius Manda	IITA	Technical backstopping on economic analyses (Section 3-protocol)
Gundula Fischer	IITA	Technical backstopping on gender and labor analyses (Section 3-protocol)
Francis Muthoni	IITA	Technical support on GIS-based soil erosion mapping (Section 3-protocol)
Anicet Sambala	IITA	M&E Support

Students: Nil	
Location(s):	Kongwa and Kiteto Districts
Start date	October 2017
End date	September 2021

Justification:
This sub-activity is for emphasis on generating and filling data gaps for the Social and Economic Domains of the studies described in Sub-activities 1.1.1.5 and 2.2.1.4.

Objectives:
To complete a comprehensive SIAF validation of agroforestry technologies under study (Double up legume, farmer managed intercropping, and contour farming).

Experiment design, implementation and data analysis:
Data collection tools developed by Bekele and used in previously by ICRAF will be modified to collect data for calculating gross margin (GM), Cost-Benefit Ratio (CBR), return to labour (USD/working-day) return to land (USD/ha) and gender roles. Direct observation and recording of cost (derived from time used to complete a farm operation task) will be adopted to estimate cost. Market survey and interviews with farmer will also be used to collected costs for items which are not possible to measure, like price of produce.

With respect to gender, focus group discussions and short concomitant survey among the same respondents, and household interviews based on gender analysis questions for SI domains in combination with participatory exercises (activity profiles, matrix scoring). There will be a workshop in Dodoma where ICRAF and other partners involved in this study will attend to develop these data collection tools for each of the technology tested. Purposive sampling (farmers who have sufficient use experience with the technologies; gender-separate and rather age homogenous groups; consideration of local hierarchies) will be adopted. Qualitative data collected will be analyzed using content analysis (pre-selected codes)/grounded theory (emerging codes) with Atlas.ti (for focus groups), and descriptive statistics with SPSS used to analyze quantitative data from the short survey. Results from gender analysis will be integrated into all domains and analyzed in combination with

biophysical, geo-spatial and economic findings. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on dataverse

SI Domain. ***As stated before, this activity is emphasizing the socio-economic components of sub-activities 1.1.1.5 and 2.2.1.4***	**Responsible institution**
Productivity: Maize grain and stover yield (t/ha); wood and foliage biomass (t/ha)	ICRAF
Environmental: Soil carbon (g/kg-soil); Soil moisture (%), Rainwater use efficiency (kg/mm/yr); Nutrient uptake (kg/ha); Nutrient use efficiency (kg/uptake); weather data; GPS points	ICRAF and SUA
Economic: Gross margin in USD/ha; Benefit-Cost Ratio-BCR;	ICRAF and IITA
Social: Perception of benefits of the technology by gender	ICRAF
Human Condition: Food availability (number of food sufficiency month per household/year)	ICRAF and IITA

Deliverables:	*Means of verification*	*Delivery date*
At least 50 farmers are mobilized and engaged in validating *G. sepium* intercropping in baby trials	Progress report	April 2019
Co-organized farmer field day and Nane-nane exhibition	Activity & progress reports	May and August, 2019
Yield (crops and biomass) and resilience benefits of *G. sepium-based cropping systems* intercropping determined	Progress report	August 2019
Economic benefits of *G. sepium* intercropping evaluated	Progress report	August 2019
Gender analysis of at least 50 farmers	Progress report	August 2019

How will scaling be achieved? NA

How are the activities in this protocol linked to those of others? NA

5.3.1.2:
Role of gender from farm-to-fork and the market, of grain legumes and dryland cereals in Kiteto and Kongwa

Research team:

Name	*Institution*	*Role*
Esther Njunguna	ICRISAT (PI)	Coordinate assembly of data from both research and monitoring activities. Engage with other Africa RISING local and CGIAR partners
Wanjiku Gichohi	ICRISAT (Co-PI)	Coordinate assembly of data from both research and monitoring activities.

Yacinta Muzanila	SUA	Support the assembly of data from both research and monitoring activities
Gundula Fischer	IITA	Backstopping design of studies and works with ICRSAT Social Scientist
Anicet Sambala	IITA	M&E Support

Locations	Kongwa, Kiteto and Iringa Districts, Tanzania
Start date	October, 2018
End date	September, 2019

Justification:
Social inequality and social inclusion have since been recognized as a foundation of issues in development for at least 40 years (Anonymous, 2015). Over time, there is evidence that more equal gender relations within households and communities lead to better agricultural and development outcomes, including increases in farm productivity and improvements in family nutrition (Abakerli, 2012). As a result, gender analysis to understand the situation and inform sustainable intensification initiatives in Kiteto and Kongwa is critical**.** An expanded description of the justification is given in the Research Protocols 2018-2019 – Appendix 1.

Research questions:
1. What are the opportunities to harness the role of women and youth in the farming communities of central Tanzania to improve the performance of grain legume in cropping systems?
2. What are the enabling factors and or limiting conditions that once addressed could catalyse improvements in the performance of grain legume in cropping systems in the semi-arid ecologies of central Tanzania?
3. What aspects of gender empowerment are significantly associated with health and nutrition outcomes?

Experiment design, implementation and data analysis:
The study will be executed through surveys and assessments such as focused group discussions, rapid rural appraisals and farming system surveys to identify gender gaps and develop a package to ensure gender equity in the region. Different methods of sampling including random and purposive sampling will be adapted. Questionnaires will be used as the data capture tools. Both qualitative and quantitative data will be captured Appropriate statistical tools will be used in the analysis. To specifically address empowerment issues related to nutrition and health, the recently released FtF-USAID project-Level Women's Empowerment in Agriculture Index (pro-WEAI) tool developed by IFPRI will be used. An expanded description of the design is given in the Research Protocols 2018-2019 – Appendix 1.

Data (with metrics) to be collected and uploaded on dataverse

SI Domain	Responsible institution
Economic*:* Poverty: Income and asset distribution by gender	ICRISAT/SUA
Social*:*	ICRISAT/SUA

Gender equity: Index on women empowerment in Agriculture Equity: Access to resources, Capacity (access to info), Achievements (income, nutrition, food security, health, well-being) Social cohesion: Incidence of social support in farming with a gender focus		
Human Condition*:* Food Security: Food availability, accessibility, and utilization Nutrition: Access to nutritious foods, Dietary diversity, Food consumption score, Nutritional status **NB: Measures through** Survey, Lookup tables, Anthropometric measurements, Participatory mapping		ICRISAT/SUA
Deliverables:	*Means of verification*	*Delivery data*
Strategy to address any gaps identified towards enhancing equity in decision making in farming	Report	30 September 2019
Through training, equip extension staff and other researchers with skills and knowledge on how to mainstream gender in Agricultural activities within the community for equity and sustainability	Training materials	30 September 2019
Gender decision support tools on the role of women in nutrition and health developed	Report	30 September 2019
How will scaling and sustainability be achieved? NA		
How are the activities in this protocol linked to those of others**?** This is a cross-cutting study that will support several activities within Kongwa and Kiteto Districts.		
5.3.1.3: Design and train development partners on the use of interactive online tool for spatial targeting of technologies and potential impacts.		
Research team:		
Name	*Institution*	*Role*
Francis Muthoni	IITA	PI – cross cutting GIS activities.
Locations:	ESA Project Countries	
Start date	2018	
End date	2019	
Justification: Development programs that scale out agricultural technologies have limited budgets and time frame despite the omnipresent need to increase their potential societal impacts. Geospatial tools for targeting are used to direct technologies to appropriate context. Existing tools for spatial targeting of agronomic technological options such as extrapolation suitability index (ESI, Muthoni et al 2017a) and		

the Impact based spatial targeting index (BSTI, Muthoni 2017b) are designed for advanced users who understand geospatial analysis and computer programming. To produce gainful impact, the existing targeting tools need to be simplified to promote their use by extension agencies with no experience in computer programming and geospatial science. The ownership of mobile phones and access to internet among the extension agencies and development partners is increasing. Availability of easy to use interactive web-based tool will facilitate extension and development agencies to prioritize available resources in order to maximize impact of out-scaling of technologies. The tool will also provide ex-ante assessment of potential impact of scaling out specific technologies at different agro-ecologies such as a-priori assessment of population of stunted children at particular locality.		
Research question: Can an interactive web-based tool effectively generate and disseminate technologies extrapolation domains to development partners & extension agencies?		
Experiment design, implementation and data analysis: The following will be needed for designing the tool: 1. Digital elevation model (DEM 30m) 2. Gridded climate data (rainfall, Tmin, Tmax, GDD, Relative humidity) 3. Gridded soil chemical analysis data (ISRIC 250 m), 4. Gridded population (by age groups) 5. Access to markets 6. Land use land cover maps 7. Livestock population layers 8. Protected areas maps 9. Administrative boundaries- GADM		
Data (with metrics) to be collected and uploaded on dataverse: NA		
Deliverables:	*Means of verification*	*Delivery date*
An interactive web-based spatial targeting tool designed and pre-tested	Report	September, 2019
How will sustainability be achieved**?** NA		
How are the activities in this protocol linked to those of others? This is a cross-cutting activity. All research team members should be able to apply the tool to their data.		

Output 5.4: A technology adoption, monitoring, evaluation, and learning framework for use by the project team and scaling partners released [led by IFPRI and used by project partners]

Activity 5.4.1: Monitor and modify the progress of technology adoption process towards scaling
Activity 5.4.2: Develop knowledge sharing centers and learning alliances within existent local and regional institutions